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TIMBER DRY DOCKS.

ALTHOUGH the use of timber is so universal in America, yet it will come as a surprise to most of our readers to learn that it is extensively used in the construction of dry docks, and that these structures are much preferred to those built of granite. That wooden docks should cost 30 to 50 per cent. less than those of stone will be readily understood; but until the nature of the North American climate is taken into consideration, it will not be realized that they are infinitely cheaper in maintenance. The alternation, however, from hot summers to hard winters proves exceedingly trying to the joints of stone docks, and it requires constant repairs to keep them tight. The alternate contraction and expansion rapidly separate the cement from the granite, and afford ingress for water, which on freezing effects a rapid disintegration of the courses.

In 1882 there were but four granite docks completed in the United States, and one was being constructed by the government in the harbor of San Francisco. At the same date there were ten wooden Simpson docks, so named after the inventor. Three of the stone docks were built by the government; the fourth, which was the result of private enterprise at San Francisco, has had its exposed surface covered with wood, and that in a locality where the winters are mild.

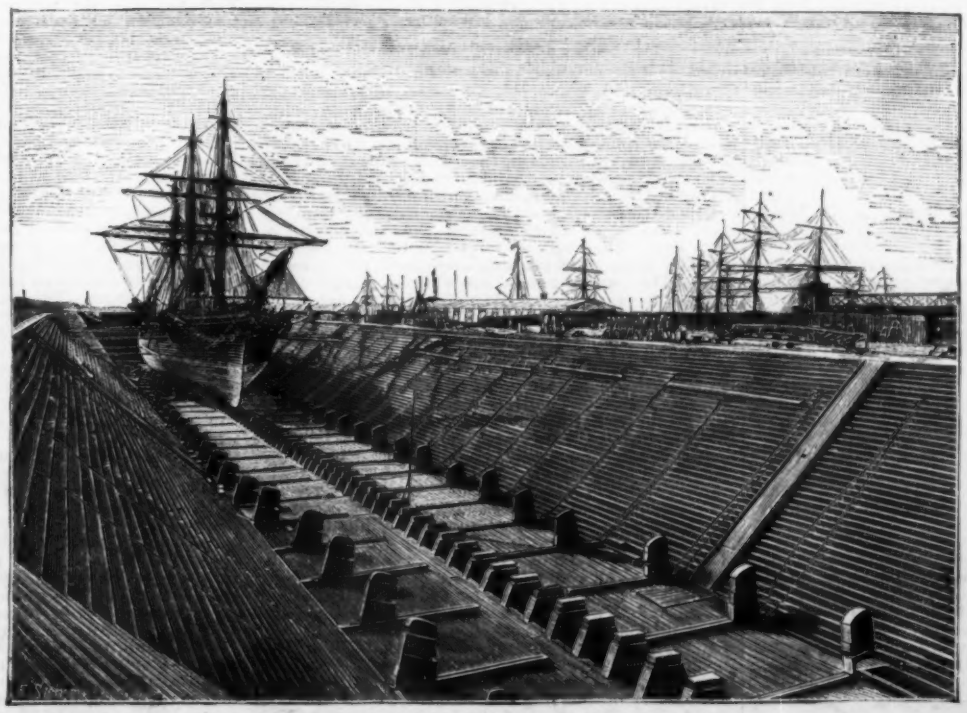
Some of the principal advantages which the Simpson docks have been found to possess over stone docks, as usually constructed, are greater accessibility, better facilities for shoring and repairing vessels, better distribution of light and air, dryness, and greater safety and comfort to the workmen in freezing weather. The greater slope given to the sides and heads of these docks, and the low, narrow altars used, furnishes safe and easy means of access for workmen to the floor of the dock, direct from any part of the coping (see illustration), and also affords much greater facilities for easily and quickly repairing, receiving, and shoring up vessels in dock, conducting the work of repairs, etc. This feature also gives more light upon the ships' bottoms, and the use of wood for floorings and altars is preferable to stone in winter, when the adhesion of ice and snow will be less upon the wood, and the discomfort of the damp, chilling air inseparable from the use of stone docks when filled with frost, is largely obviated. Careful investigation shows that extensive repairs and renewals to well-built timber docks are not necessary until after twenty years' service, and then only to the parts above the tide water; also that the piles, floor and keel timbers, sills and abutments, and the timbering generally below low-water line of the oldest Simpson docks, are still in use and in a good state of preservation; and although the exposed timbers are more or less worn from constant use, and all are deeply water-stained, they are substantially as sound and serviceable as when put in twenty-eight or thirty years ago.

The method of constructing these docks will be seen from our engravings. These views represent two different docks, built by Messrs. J. E. Simpson & Co.; the unfinished one is at Baltimore, and the completed example is the Erie Basin, Brooklyn. The former is 470 feet long on the top, 437 feet at the bottom, the width on the top of the body being 113 feet, and at the bottom 45 feet. The contract price was $375,500, and the time of building twelve months. Nearly the whole area of the dock was covered with water, and near the gate to a depth of 10 feet or 12 feet. Below the mud at the bottom of this water was a hard clay. The Erie dock is of the following dimensions:

	Ft.
Length over all on coping	540
" inside of caisson when on outer abutment	510
Length inside of caisson when on inner abutment	490
Width on top in body	124
" floor "	52
" " at entrance	46
" top "	100
Depth of gate sill below coping	27
" " " high water	22

The dock, together with an adjoining one of larger dimensions, is built upon spruce foundations throughout, the floor foundation piles being driven in rows spaced 3 ft. from centers transversely, and about 4 ft. 8 in. longitudinally, upon which are fitted and secured heavy transverse floor timbers of yellow pine, covered with spruce planking to form the floor, and carrying the keel blocks, the latter being additionally supported by four rows of piles driven under these floor timbers, and capped with yellow pine timbers along the axis of the dock. The heads of the piles along the keelway are also inclosed in a continuous bed of Portland cement concrete. Open box drains are provided at each side of the keeling beneath the floor timbers, leading to the drainage culverts at the head of each dock. The sides and heads of the docks are built with a slope of about 45°; the altars to high water level are built of yellow pine timber, 9 in. rise and 10 in. tread, and are bolted to side brace timbers, which are supported by piles, and abut upon the ends of the floor timbers. The altars are carefully filled in behind with clay puddle as the sides are built up, and from the level of high water to the top of coping the sides are built of concrete *en masse*, faced with Hoope's artificial stone, the altars being continued of the same material to the coping level. The keel blocks are placed upon every floor timber, and bilge blocks of the usual form, sliding upon oak bearers, upon every other floor timber. Lines of close sheet piling of tongued plank inclose the floor of the dock, and also extend entirely around the dock outside of the coping, and across the entrance of the outer end of the apron, and at each abutment, forming cut-offs to exclude the tide water, etc. An iron caisson, used to close the dock, is made with sloping ends corresponding substantially with the slope of the side walls in the body of the dock. This bears against the sill and solid timber abutments the whole length of the hull and the stem, no grooves being used. Each dock has two gate sills and abutments, the outer being to allow repairs to the inner.

TIMBER DRY DOCK AT BALTIMORE, MARYLAND.



TIMBER DRY DOCK--ERIE BASIN, BROOKLYN, N. Y.

A timber dock, constructed under the superintendence of Mr. Simpson, who is now 73 years of age, was opened at St. Johns, Newfoundland, on December 15, of last year. The following are the dimensions:

	Ft.	In.
Greatest length on coping, head to outer gate sill	610	10
Greatest length on floor, head to outer gate sill	569	6
Greatest width of body on coping	132	6
Greatest width of body on floor	49	10
Least width of entrance, inner abutment, on coping	84	9
Least width of entrance, inner abutment, on floor	52	9

Greatest draught of water over inner gate sill, high water, spring tide, 25 feet.

This dock is located at Riverhead, in the harbor of St. Johns, and is similar in shape and construction to the wooden graving docks in Brooklyn, Philadelphia, and Baltimore.

It is built upon spruce pile foundations, except the floor, which rests upon a bed of Portland cement concrete, varying from 2½ feet in thickness at the head to about 6 feet at the entrance. The concrete floor foundation itself rests upon a glacial deposit of compacted slaty gravel immediately overlying the bed rock.

It would appear that this dock has been constructed with great dispatch, the contract having been made March 17, 1883, subject to the Legislature passing an act authorizing the Government to ratify and confirm the same, which act was duly passed, April 21, 1883. The site provided by the Government was only partially bare at low water, and a portion of it was occupied with pile wharves, etc. The contractors arrived on the ground May 9, 1883, and the first pile was driven May 28th. On December 24th following, all outside work was suspend-

ed for the winter until April 24, 1884, when it was resumed, and the inclosed site first pumped dry ready for excavation, which began the following day.

The entrance works were completed on November 28th following, and water first admitted to the dock on the 29th; the caisson was floated and set in place at the outer abutment November 30th, and the dock first pumped out December 2d.—*Engineering.*

MODERN RAILROAD FACILITIES.*

By WM. BARNET LE VAN.

HISTORY.

EIGHTY years ago, Oliver Evans, who deserves at this day all the honor that can be conferred on man as one of Philadelphia's noblest sons, made the first application in the streets of this city of steam to a carriage in America, and, in fact, the first locomotive engine. This experiment was more successful than any that had preceded it.

About this time, Evans publicly stated that "The time will come when people would travel in stages, moved by steam engines, from city to city, almost as fast as birds fly—fifteen or twenty miles an hour—passing through the air with such velocity, changing the scene in such rapid succession, and with the most exhilarating exercise. *A steam carriage will set out from Washington in the morning—the passengers will breakfast in Baltimore, dine in Philadelphia, and sup in New York the same day.*

"To accomplish this, two sets of railways will be required, laid so nearly level as not to deviate more than two degrees from a horizontal line, made of wood or iron, or smooth paths of broken stone or gravel, with a rail to guide the carriages, so that they may pass each other in different directions, and travel by night as well as day." It is a singular coincidence that Evans should have made one of the first experiments in propelling a carriage by steam in the very city destined to become, in the course of fifty years afterward, the head center of one of the most important railroads in the world, "The Pennsylvania."

The Fastest Railroad Trains in the World.—As there has been considerable discussion of late as to which road runs the quickest trains, I have collated from the different time tables and other sources the best time made, that the community at large may know what is being done both at home and abroad. England stands first, both as to the number and the quickest runs, as follows:

English Long-distance Train.—Northwestern Limited Mail. (Third Class.)

Between	Miles.	Time.	Miles per hour.
Euston....(leave).....	.....	8·50	45
Rugby.....	82¾	10·40	
		10·44	45
Tamworth.....	110	11·20	
		11·24	45½
Stafford.....	133½	11·55	
		11·59	44⅛
Crewe.....	158	11·32	
		12·38	46⅜
Wigan.....	194	1·24	
		1·30	40
Preston.....	209¼	1·53	
		1·57	40·6
Carlisle.....	299¼	4·10	
		4·18	48½
Carstairs.....	372¾	5·53	
		6·00	36
Holytown Junction.....	389	6·27	
		6·29	—
Coatbridge.....	393⅓	6·37	
		6·40	40½
Larbert.....	409	7·03	
		7·07	—
Stirling.....	417¼	7·21	
		7·24	40
Perth (ticket station).....	450½	8·13	
		8·15	39⅕
Perth....(leave).....		9·05	
		9·55	32
Forfar.....	482¾	9·69	
		10·28	37
Bridge of Dun.....	498⅓	10·29	
		11·37	
Aberdeen (ticket station)..	540¼	11·40	

Actual miles per hour.... 36·4 Actual running miles per hour.....41·8

French Long-distance Train.—Paris, Lyon, and Mediterranée. ("*First Class Only.*")

Between	Miles.	Time.	Miles per hour.
Paris.....		8·55	36
Montereau.....	49	10·17	
		10·20	41½
Laroche.....	96½	11·28	
		11·31	41¾
Tonnerre	122¼	12·08	
		12·33	39½
Dijon.....	195½	2·24	
		2·29	42
Macon.....	273¾	4·21	
		4·26	34½
Lyon.....	314⅜	5·37	
		6·08	40
Valence.....	383¾	7·51	
		7·56	42½
Avignon.....	460¾	9·45	
		9·50	38⅔
Marseilles.....	536	11·47	

Actual miles per hour.....36 Actual running miles per hour... .39¾

A celebrated writer in England suggests that this road "should run a car with projecting glass sides and cheap fares, for factory hands, to see the sights there are between Leeds and Carlisle." Observation cars, such as are run by the Pennsylvania Railroad in this country between Altoona and Cresson, would answer a better purpose. The views between Derby and Manchester are grand, and the panorama seen from the Westmoreland heights as you "spin" along down grade, at 70 miles an hour, is beyond description. The locomotives of this road, like those on the Pennsylvania, have nearly one-third of their time occupied in ascending very steep grades, but they accomplish their task well—the highest point on this road being 1,015 feet above the sea. There are four trains run between Liverpool and Stockport, 37¾ miles, in *forty-five minutes*, running average 50½ miles an hour; and one between St. Pancras (London) and Kettering, 72¼ miles, in *eighty-seven minutes*, running time 49·8 miles an hour; and between Bedford and Kentish Town, 48 miles in *one hour*.

North Eastern.—This line is more noted for dividends than fast running from the fact of easy grades. It has the most comfortable equipment of trains in England, and withal the most "democratic." Its *third class cars* are so inviting that even a "dude," entering by mistake, has been known to travel from York to Newcastle without loss of respectability. This company is also "democratic" enough to "honor America's invention in regard to *brakes;* almost every train, on a small branch, has the Westinghouse automatic." The excursion rates on this line are the lowest in England. The train between York and Darlington, a distance of 44¼ miles, is run in *fifty-three minutes*, an average of 50 miles an hour. From York to Newcastle, 80¼ miles, is covered in *one hour and forty-two minutes*, running average 47½ miles per hour. This line mounts up to 1,469 feet above the sea, on Stainmoor, where it crosses the boundary of Yorkshire and Westmoreland. This is the highest passenger route in England, and has more romantic and beautiful views than any others. These abound either on the sea coast, from Flamborough to Berwick, or along the valleys.

Great Eastern.—This line, like the North Eastern, has fitted all its trains with the Westinghouse brake. This line follows the curve of the east coast, and is thus continually crossing (little) transverse valleys; the greatest height between Colchester and Yarmouth is only about 125 feet above the sea, near *Westerfield.*

The best long distance run is between Norwich and Doncaster, 163 miles (seaside express), in *three hours and thirty-five minutes*, a running speed of 47½ miles an hour. The fastest run is made between Lincoln and Spalding, 38¼ miles, in *forty-seven minutes*, averaging 48⅝ miles an hour.

London, Brighton, and South Coast.—Brighton being the Long Branch of England, and formerly the residence of the King of England, who according to an act of Parliament must live within *fifty miles* of London. This has been the means of making the place a popular resort. The expresses on this road, like all running to seaside resorts, have very heavy trains.

The best run between London Bridge and Brighton, 50½ miles, is covered in *sixty-five minutes*, an average of 46·6 miles an hour.

London, Chatham, and Dover.—This line deserves great credit for the spirited way in which it runs over its hilly route. The 74 miles between Herne Hill and Dover is covered in *one hour and thirty-six minutes*, an average of 42¼ miles an hour.

London and South Western.—This line is almost level to *Basingstoke*, and gets steeper as it goes west. There are three expresses and thirteen long runs, averaging 47½ miles. The *longest* and quickest is from Yeovil Junction to Exeter, 48·5 miles, in *sixty-three minutes*, an average of 46·6 miles an hour.

South Eastern.—This line has steep grades except where the line runs between Tunbridge Junction and Ashford, nearly at sea level, and quite straight for 20 miles. The distance by Cannon Street, London and Dover, 74½ miles, is covered in *ninety-nine minutes*, or at the rate of 45 miles an hour.

Scotch Lines.—There are three Scotch companies that run fast express lines, and they do this over a line beset with grades.

Caledonian.—This line runs fast expresses, but, owing to the steep grades of unusual length, the running average is below the former lines. If a passenger wishes to see what 70 miles an hour means, he can on this line readily be satisfied, and nowhere better than here ascertain how little compensatory effect a speed of *seventy* miles an hour, down a grade of $\frac{1}{70}$, can have in making good the loss of time going *up* the other side. On this line, between Carlisle and Beattock, 39·75 miles are covered in *forty-eight minutes*, averaging 49¾ miles an hour, and between Carlisle and Carstairs, by the Limited Mail, 73·5 miles is spanned in *ninety-five minutes*, or an average of 48·5 miles an hour.

North British.—This line runs the Midland (England) expresses between Edinburgh and Carlisle, and also runs a local express of its own between Edinburgh and Glasgow. Between Polmont and Cowlairs, a distance covered within the hour, but as the speed is so uniform it does not attract the attention of the passengers, and they are surprised if they undertake to time it with their watches.

Great Northern.—The most of the trains on this road are very long, but they are run at very high speed with unusual punctuality. In 1880 this road ran four express trains to Leeds, which covered the distance between Grantham and Wakefield, 70 miles, in *seventy-eight minutes*, or on an average of 53·8 miles an hour, which is slightly faster than the Swindon trains above mentioned; for some reason these trains have been discontinued. Now, on Sundays, the 5 P.M. runs from Hitchin to Peterborough, 44·25 miles, in *fifty minutes*, or an average of 53 miles an hour. This road also runs trains between Grantham and Doncaster, 50¼ miles, in *fifty-eight minutes*, or an average of 52·25 miles per hour every day. This road has forty-nine long runs, averaging 73¾ miles at a running average of *fifty miles* per hour. The longest run is made from King's Cross, London, to Grantham, 105½ miles, in *two hours and four minutes*, running average of 51 miles an hour.

London and Northwestern.—This is the oldest established railway company in England, and does the largest business, it being the first built and has the lightest grades, but in point of speed is far behind other companies. The train carrying the Irish mail to Holyhead, from Euston Station (London), over this line, and dubbed years ago "The Wild Irishman," has now sunk into comparative obscurity with its rate of 42 miles an hour. Its fastest trains are between Northampton and Willesden, a distance of 60¼ miles, which is covered in *seventy minutes*, an average of 51⅔ miles per hour, also between Rugby and Willesden, 77¾ miles, is covered in *ninety-two minutes*, or an average of 50⅛ miles per hour. There are twenty trains between Liverpool and Manchester, distance 31⅛ miles, in *forty-five minutes*, averaging 45 miles an hour.

Midland.—This road is remarkable for very high speed, although it has very heavy grades to contend with. It, like the Pennsylvania Railroad, is noted for its energy in developing "through" services and the opening up of branch lines connecting with its own. The scenery on this line also, like the Pennsylvania, is grand, including some of the loveliest views in England.

A Summary of the Fastest Trains in the World.

Name of Road.	Between	Distance in miles.	Time. H. M.	Running average.	Number of trains.
Baltimore and Ohio.	Baltimore and Washington.....	40	·45	53⅓	2
Manchester, Sheffield, and Lincoln	Manchester and Warrington.....	16	·18	53⅓	16
Great Western..	Paddington and Swindon.....	77½	1·27	53⅓	4
Great Northern	Hitchin and Peterborough.....	44¼	·50	53	1
"	Grantham and Doncaster.....	50¼	·58	52¼	1
"	Grantham and London	105½	2·04	51	2
"	Grantham and York.....	82½	1·39	50	2
North Western	Northampton and Willesden.....	60¼	1·10	51⅔	1
"	Rugby and Willesden.....	77¼	1·32	50⅛	1
Midland.....	Liverpool and Stockport.....	37¾	·45	50⅓	4
"	London and Kettering	72¼	1·27	49⅔	1
"	Bedford and Kentish Town.....	48	1·00	48	10
"	Leicester and St. Pancras.....	99¼	2·07	47	1
North Eastern	York and Darlington.....	44¼	·53	50	1
Caledonian	Carlisle and Beatlock	39¾	·48	49¾	1
"	Carlisle and Carstairs	73½	1·31	48½	1
Bound Brook	Trenton and Bound Brook.....	27·1	·31	50	1
"	Jersey City and Philadelphia.....	89·4	1·52	47·9	2
"	Philadelphia and New York.....	90·4	2·00	45·2	2
Pennsylvania	Germantown Junction and Jersey City.	84·3	1·44	49·4	2
"	Philadelphia and Jersey City.....	89·7	1·53	47·1	2
"	Philadelphia and New York.....	90·7	2·00	45·2	2
North British.....	Polmont and Cowlairs.....	23½	·29	48·6	1
Great Eastern.	Lincoln and Spalding.....	38¼	·47	48⅝	3
Glasgow and Western..	Carlisle and Dumfries.....	33	·42	45	1
Brighton	London Bridge and Brighton.....	50½	1·05	46⅔	1
Chatham and Dover....	Herne Hill and Dover.....	74½	1·36	46¼	1
South Eastern.....	London and Dover.....	74½	1·39	45	2
Berlin and Cologne	.....	404	9·00	47·1	1

Manchester, Sheffield, and Lincoln.—This railway runs the greatest number of fast short distance trains in the world, numbering sixteen daily, between Manchester and Warrington, a distance of sixteen miles in *eighteen minutes;* running time 53·3 miles an hour. Fourteen of the above miles are practically level. None of these are very heavy trains, and their punctuality is excellent.

Great Western.—This line is unique in its track; which is broad gauge (seven feet) from Paddington to Penzance, mixed gauge as far as Exeter, and most of its system has been laid with *longitudinal* sleepers, the same as in use on our city passenger railways. It has the smoothest running track in the world, and the speed between Paddington and Swindon is the highest of any long run in England.

For years this road was far ahead in speed, the flying trains known as "Dutchman" running just as they do now about twenty years ago. In fact, on June 13, 1846, an experimental trip was made by the new locomotive, "The Great Western." The train weighed one hundred tons. The train started from Paddington, and arrived at Dicteot in fifty-four minutes; distance fifty-one miles, or at the rate of fifty-six miles an hour.

This company runs four express trains to Exeter, a distance of 194 miles, at the rate of 46½ miles an hour; the distance between Paddington and Swindon, 77 miles, is run in *one hour and twenty-seven minutes*, or at the rate of 53⅓ miles an hour. (The two afternoon trains are called "Zulu," because they began to run the day after the Prince Imperial of France was killed; the two morning ones are the "Dutchman.") The running average of the four Plymouth trains, *between Exeter and Paddington*, is as high as 50½ miles an hour (distance 194 miles), and the distance between Taplow and Swindon, which is very smooth and level, the 55 miles is

* A paper read at the meeting of the Franklin Institute, December 17, 1884.

of 23·5 miles, is covered in *twenty-nine minutes*, or at the rate of 48·6 miles an hour; and between Carlisle and Edinburgh 98·25 miles is run in *two hours and twenty minutes*, averaging 42 miles an hour.

Glasgow and South Western.—This line is a much easier one than the two former, the highest point reached being only 625 feet above the sea. The Midland (England) cars are run by this line between Glasgow and Carlisle; and between Carlisle and Dumfries, a distance of 33 miles is run in *forty-two minutes*, or an average of 47 miles an hour; between Dumfries and Kilmarnock, 58½ miles in *one hour and eighteen minutes*, or at the rate of 45 miles an hour.

Berlin to Cologne.—By the Lehrte route, stopping for dinner at Hanover, viz., Hanover and Stendal. The distance from Berlin to Cologne by this route is 404 miles, and is spanned in *nine hours*, or an average of 47·1 miles an hour.

Fastest English Long-distance Train.—(East Coast Route.)

	Miles.	H. M.	Miles per hour.
Glasgow .....(leave).....	.....	8·40	
Cowlairs	1½	8·46	
		8·48	
Polmont Junction.....	25	9·19	45½
		9·20	
Haymarket)	46	9·50	42
		9·52	
Edinburgh) (Waverley Stat'n)	47¼	9·55	
		10·00	
Berwick	104¾	11·15	46
		11·20	
Newcastle.....	171½	12·45	47
		12·50	
Darlington.....	207½	1·38	45
		1·41	
York (refreshments)...	251¾	2·35	49⅛
		3·05	
Grantham.....	334¼	4·44	50
		4·50	
King's Cross (London).....	439¾	7·00	48¾

The *North British* Company runs these trains between Glasgow and Edinburgh, the *North Eastern* between Edinburgh, and the *Great Northern* between York and London.

This time table is the fast express known as the "Flying Scotsman," which also leaves King's Cross (London) at 10 A. M., stops an hour for dinner at York, and reaches Waverley Station, in Edinburgh, at 7 P. M., distance 439¾ miles.

Average miles per hour from King's Cross to Edinburgh, 48, and Edinburgh to Glasgow being 47 miles per hour.

French Fast Long-distance Train.—Paris, Orleans, Tours, Bordeaux. (First Class.)

Between.	Miles.	Time.	Miles per hour.
Bordeaux (Bastide)....(dep.)....	.....	7 50)	
		8·21)	42
Libourne	21¾		
		8·23)	
Coutras.....	31¾	8·39)	37½
Angouleme.....	82¾	9·50	44¼
		10·15	
Ruffec.....	112	10·56	42 8
		10·59	
Poictiers..... ...	153	11·55	44
		12·00	
Chatellerault	173¼	12·30	40½
		12·32	
St. Pierre des Corps.....	215½	1 30	43¾
		1·35	
Blois.....	248½	2·20	44
		2 22	
Les Autrais.....	285	3·10	45⅝
		3·15	
Etampes.....	324	4·07	45⅓
		4·10	
Paris	359¼	4·56	45¼

Actual miles run per hour..... 29¼ Actual running miles per hour. 43¾.

AMERICA.

Baltimore and Ohio Railroad.—This road, in times gone by, has marked many an epoch in railroad history, and, as the first passenger railroad in the world, has ever been in the lead in important steps forward. Building its own locomotives, which for half a century have been accorded the highest place in America, with its grand motive-power and superb equipment throughout, it makes the fastest short distance time in the United States, and second to none abroad.

This road, on its Baltimore and Washington line, forty miles long, covers the distance in *forty-five minutes*, being at the rate of 53·3 miles per hour. There are also four trains spanning the distance in *fifty minutes*, averaging 48 miles an hour.

Philadelphia and Reading Railroad, Bound Brook Division.—This road follows next in order. This line runs a train to and from New York and Philadelphia in *two hours*, including the ferrying across the North River at the former place. The distance between the cities is by this route 90·4 miles, *via* Ninth and Green streets. This distance is covered in the above time, an average of 45·2 miles per hour. The train time between Philadelphia and Jersey City, including four stops and one change of locomotive, is *one hundred and twelve* (1 hour and 52 minutes) *minutes*, distance 89·4 miles, is run at the rate of 47·93 miles per hour; and between Trenton and Bound Brook, 27·1 miles is covered in *thirty-one minutes*, or an average of 50 miles an hour. There are a few really fine bits of running on this line. The writer has several times averaged *seventy miles* an hour for five successive minutes from Skillman east, this portion of the road being straight for a distance of 14 miles. The alignment of this line is very favorable, none of the curves exceeding two degrees between Jenkintown and Jersey City.

Pennsylvania Railroad, New York Division.—This line also runs a train from Philadelphia to New York, distance 90·7 miles, in two hours, making one stop, including ferriage at New York, averaging 45·4 miles an hour. Between Philadelphia and Jersey City, 89·7 miles, including one stop, the time is *one hour and fifty-three minutes*, averaging 47·1 miles an hour; and between Germantown Junction and Jersey City, 84·3 miles is covered in *one hour and forty-nine minutes*, or at a rate of 49·4 miles an hour.

This route is unfortunately a continuous series of curves and re-curves, ninety in number, varying from one degree (5,730 feet) to nine degrees (636 feet radius) radius.

With all these drawbacks, the Pennsylvania Railroad Company every day accomplishes a speed of nearly *fifty miles an hour*, passing over the number of curves before stated, whose total curvature would describe over ten complete circles.

But in long distance runs the Pennsylvania Railroad stands first in the world. The New York and Chicago Limited train covers the distance between the two cities, 912·2 miles, in *twenty-six and one-half hours*, including the ferriage at New York and eight stops which occupy *sixty-six minutes*, being an average running time of 36·18 miles per hour. From Chicago to Fort Wayne, a distance of 148 miles is covered in *four hours*, an average of 37 miles an hour.

In fact, there are no such distances yet run in Europe as across the American continent by the Chicago limited. By this train the most luxurious traveling in the world is done, besides the speed is the fastest of any long distance train. This train is made up and composed exclusively of drawing-room, dining-room, smoking-room, and sleeping cars, the baggage and kitchen composing one car. The sleeping-car charge and "extra fare" are represented in the one "extra fare" ticket. No half "extra fare" tickets are sold; children between five and twelve years of age being required to purchase whole "extra fare" tickets, in connection with half fare passage tickets. Extra fare tickets include a double berth in sleeping car or seat in section of same. A double berth will hold two persons; a section contains two double berths, and a drawing-room contains two double and two single berths. Two persons desiring to occupy the same berth will be charged one and one-half the extra fare. At least one passage ticket and one extra fare ticket will be required for each double berth occupied.

The Fastest Long Distance Runs in the World.—Arranged according to distance.

Name of Road.	Between.	Miles.	H. M.	Running Average.	Train.
Pennsylvania.....	Chicago and Ft. Wayne....	148	4·04	36·4	) New York and Chicago Limited.
"	Altoona and Harrisburg...	132	3·20	39·5	
"	Pittsburg and Altoona.....	117	3·15	36	)
Great Northern (Eng.).....	Grantham & King's Cross..	105½	2·05	51	Fast Express from Manchester.
Midland	St. Pancras and Leicester.	99¼	2·07	47	Down Scotch Express.
Paris, Lyon & Mediterranee	Laroche and Dijon.....	99	2·41	37	7·15 from Paris, first-class only.
North British.....	Carlisle and Edinburgh....	98¼	2·20	42	Night Express.
Midland.....	Derby and Liverpool.....	91½	2·04	44¼	12 N. from St. Pancras.
"	Skipton and Carlisle.....	86¾	1·55	45·2	Night Express.
London and North Western	Preston and Carlisle.....	90	2·10	41½	One each way.
London and North Western	Chester and Holyhead.....	84½	2·	42¼	One each way.
London and North Western	Rugby and Euston.....	82¾	1·50	45	One each way.
Great Northern.....	Grantham and York.....	82½	1·39	50	One each way.
NorthaEstern.....	Newcastle and York.....	80¼	1·42	47⅓	One each way.
London, Chatham & Dover	Victoria and Dover.....	78	1·45	44⅔	One each way.
SouthEastern.....	Cannon St. and Dover.....	74½	1·39	45	One each way.
NortheWstern.....	Rugby and Willesden.....	77¾	1·32	50½	
Pennsylvania.....	Ger'n Jun. and Jersey City	84·3	1·44	49·4	One each way.
Great Western.....	Paddington and Swindon..	77	1·27	53⅞	Two each way.
Caledonian	Carlisle and Carstairs.....	73½	1·35	48·5	Limited Mail.
London and North Western	Carlisle and Carnforth.....	62¾	1·25	44¼	Limited Mail.
Midland	Bedford and Kentish Town	48	1·	48	All Manchester Expresses.
Paris, Orleans, Tours, Bordeaux.....	Ruffec and Poitiers.....	41	0·56	44	
Paris, Orleans, Tours, Bordeaux.....	Les Aubrais and Etampes..	39	0·52	45⅓	First-class.
Baltimore and Ohio..... ..	Baltimore and Washington	40	0·45	53½	One each way.

The Fastest Long-distance Train in the World.—New York and Chicago Limited.

Between.	Miles.	Time. Hours.	Minutes.	Minutes lost in ferriage & stops.	Minutes	Miles per hour.
New York City (Eastern time).....	.....		A. M. 9·			
Jersey City.....	1·		9·08	8		
Jersey City.....	.....		9·15	7		
Philadelphia (Broad Street Station)..	89·7		11·14			
	.....		11·25	11	119	45·4
Harrisburg	105·2		P. M. 2·05			
	.....		2·10	5	160	39·49
Altoona.....	131·6		5·35			
	.....		5·40	5	205	38·46
Pittsburg... (Central time)	116·7		9·00			
	.....		8·17	17	200	35·
Alliance.....	83·		11·07			
	.....		11·12	5	170	29·26
Crestline	106·		A. M. 2·27			
	.....		2·30	3	195	32·6
Fort Wayne.....	131·		6·			
	.....		6·05	5	210	35·9
Chicago.....	148·		10·30	.....	265	33·33
Totals.....	912·2		26·30	1·06	25·24	289·44
Average miles per hour.....	.....		.....	.....	.....	36·18

The dining cars are on the Western plan, not restaurant cars. *Table d'hote* meals are served at the fixed price of $1, from bills of fare, representing all the substantials and delicacies of the season, which can hardly be matched in the country for cleanliness, juiciness, and variety. The smoking-room cars are supplied with easy chairs and lounges, instead of stiff pews. You can take a seat in a rattan chair made deep and with soft cushions, or take your place at a writing desk on which is paper printed with the name of the Limited Express, and with a library of books above you, and be waited upon by a wag of a black porter, who will bring in drinks of any kind, cigars and lunch, with cards and card tables at hand. A trip across the continent in one of these trains is a luxury fit for a king, and just the thing to rest a wearied merchant or official, the landscape passing so rapidly and the time made in general with great thoroughness.

Passengers paying so unusual a rate are, as a general thing, more exacting than first-class passengers ordinarily. The company expecting this, special notice is given to all the company's people to be considerate and patient with the passengers. This train leaves New York at 9 A. M. (eastern time), and reaches Chicago at 10·30 A. M. (central time) the next day. Returning, it leaves Chicago at 4·51 P. M. (central time), and reaches New York at 7·30 P. M. (eastern time) the next day. The above time table will show how the run is made.

It will be seen by this table that the speed in America, both for short and long distance runs, is second to none obtained elsewhere.

The *average* speed in this country in long runs does not quite equal the English, but it must be remembered that our roads have heavier grades and *more* curves, the latter being of smaller radii than is allowable on English and French roads. Then, again, the law of England gives the railroad companies exclusive right over their tracks, and any one trespassing thereon is liable to fine and imprisonment. When the law in this country steps in, as in England, we will be able to far surpass her. I have been told that we are running fast enough, but speed is a means to an end; the greater the expedition compatible with safety, the more benefit will be derived by all parties. I am, every day, also asked if there is not more danger in the running of fast trains than with slow trains. As for *safety*, the safest line is the one which is the best managed, but the one which runs the most and fastest trains is obliged to be the best managed; thus, those who prefer *slow* trains must yet acknowledge their debt to fast trains.

Railroad mortality statistics of England and some parts of the Continent of Europe have been compiled and published in France, from which it appears that the greatest fatality occurs on the French railways:

The French Railroads kill, annually, one in every.....		2,000,000
" English " " " " " "		5,250,000
" Belgian " " " " " "		9,000,000
" Prussian " " " " " " ...21,500,000		
" French " wound, " " " "		500,000
" English " " " " " "		750,000
" Belgian " " " " " "		9,000,000
" Prussian " " " " " "		4,000,000

Roundly speaking, French railways kill five times as many as English, English not quite twice as many as Belgian, and Belgian nearer thrice than twice as many as Prussian, which are much the least fatal of the four. —*Jour. Frank. Inst.*

SURFACE AND ELEVATED CABLE RAILROADS FOR OUR EASTERN CITIES.

AMONG the subjects which have been brought to the notice of the Eastern public during the past eighteen months, through the medium of the press and corporate advertisement, that of cable traction railways has been most conspicuous.

While it is thus generally conceded that the rapid growth of our leading cities demands increased facilities of transit, both in point of rapidity, capacity, and comfort, toward which the successful operation of the elevated railroads will always remain the first and most brilliant advance, yet many contradictions and erroneous impressions have grown out of the discussion of the subject, in passing verdict on the various systems which have been brought forward to solve the problem.

This seeming obscurity and conflict of statements is attributable on the one hand to gross exaggerations of the benefits and economy attending the introduction of cable railroads advanced by individuals and corporations holding patents, franchises, and stock which they seek to dispose of; and on the other hand the hackneyed protests of property owners have contributed misstatements in the other extreme; and commissions, mayors, and legislative bodies have been led to the belief that cable roads, their much-urged necessity and virtues, are merely put forward as a bait for speculative enthusiasm and as a basis for stock operations.

Setting aside all prejudices, however, and seeking neutrally to review the cable transit question from an

engineering and business point of view, the following brief summary and criticism of its salient features may be noted:

1st. The operation of cars by endless cable traction is *theoretically* the most perfect of all known or *proved* methods.

2d. The *practicability* and *economy* of cable roads have been thoroughly demonstrated in San Francisco and Chicago. In San Francisco the *hilly* topography renders the operation of street cars wholly dependent on this method, so that it may be fairly spoken of as *more than a success*, as far as the experiences in that city go.

In Chicago, where the cable system is operated on comparatively *level* ground, and has long been in use as a substitute for horse power, the change has proved lucrative to the promoters of the reform, while the public enjoys the benefits of ordinary horse cars with the additional advantages of a more rapid and pleasant transportation. For, as is well known, the latter quality is peculiar to the cable system, which when properly operated is not attended with the disagreeable noise, clatter, mud spattering, and overcrowding common to the usual street car traffic. And on these accounts, not to speak of a more ornamental appearance, the system appreciates rather than depreciates adjoining real estate.

3d. While the construction cost or bonded indebtedness per mile is greatly in excess of that of horse railways, the saving in operating expenses is so large as to pay a greater interest on the increased capitalization of the road, even after submitting to a relative diminution in the fare charge.

The weak features working against the economic operation of cars by the cable system have been twofold:

1st. Disturbances in the regularity of operation, caused by the influx of water and other street material through the slot into the cable tube, where their accumulation, owing to freezing and inefficient drainage, obstructs and damages the traveling cable.

2d. The expensive construction of the underground tube and consequent large cost of building the road.

In the Corning system, here illustrated, lately invented by Mr. Frederick G. Corning, a mining engineer and metallurgist at 78 Broadway, this city, certain improvements and combinations are embodied, having in view the elimination of the aforementioned drawbacks.

Mr. Corning, who is a graduate from the Royal School of Mines of Freiberg, Germany, is not only actively engaged in mine expert work, but has devoted careful attention to cable railroads; and after thoroughly studying the defects in that art, has planned the system illustrated in our to-day's issue.

His design presents a feature of unique novelty in its adaptation to the existing conditions of elevated railway traffic in this city and to the concomitant solution of the underlying surface railway problem.

Fig. 1 shows a tube of new construction, divided into two compartments. One of the divisions serves as a side drain into which the vertical slot connecting with the street enters, thus keeping all *debris* and foreign material out of the tube proper. The drain can be given any desired grade independent of the grade of the cable tube; and, at suitable intervals, the same can be put in connection with the city drains or with accumulating cisterns.

A brush or other cleaning device is run through the drain by connection with the traveling car above, as shown in Fig. 3, and thus the impurities falling through the slot are continuously removed from the drain or side compartment, which, being entirely free from sheaves or other mechanical obstructions, permits of such automatic clearance.

Fig. 2 shows a modification of a grip adapted to reach over the partition in the cable tube as seen in Fig. 1.

The Corning system proper is represented in Figs. 4, 5, 6, 7, 8, and 9.

It has as object the conjoint operation of elevated and street railways, by the use of endless cables. The motor consists of the elevated locomotives themselves, assisted by a stationary engine; or the latter, shown in Figs. 8 and 9, may be used alone to operate both elevated and surface cars, thus relieving the elevated structure of the excessive strain caused by the numerous heavy locomotives.

The elevated or upper cable is situated between the tracks of the elevated railway, where it is conducted on guide-pulleys. Where the same in that position would interfere with switching, it is carried by guide sheaves under the ties, and again conducted back to its normal position on top of the ties when such switching points shall have been passed.

The lower or street cable travels about 1-3 to 1-2 as fast as the upper or elevated cable, the two cables being connected by proper transmission pulleys. A tightening mechanism is included in the system. The same compensates for expansion and contraction of the entire cable system with fluctuating temperature, a consideration of unusual importance, as the upper cable is exposed to the rays of the sun, while the lower one is more or less in the shade.

Mr. Corning's method of joint operation would lessen materially the cost of each road, both as to construction and operation. And, as a whole, the plan is one of striking merit, toward the serious consideration of which the signs of the times in the art of city transit are tending.

MILITARY BALLOONING.

SOME interesting particulars of former efforts to adapt balloons to military purposes have been collected by Lieutenant R. S. Mackenzie, R.E., who has been connected with the balloon force for some time, and is now in Egypt. It would appear, says *Engineering*, that the present balloon expedition in connection with the operations in the Soudan will not be the first effort made in Egypt in this direction. In 1794 aerostatics played a successful part in the battle of Fleurus, fought in 1794, and a company of aeronauts was constituted and formed part of Napoleon's expedition to Egypt, but no opportunity occurred of testing the usefulness of the corps. At Solferino, however, the French aeronauts did useful work for their side, but since that time bal-

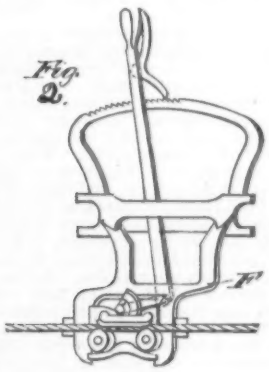
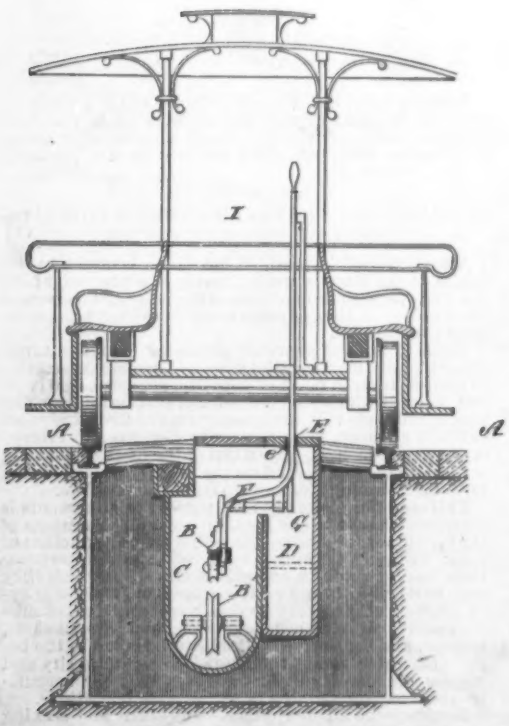
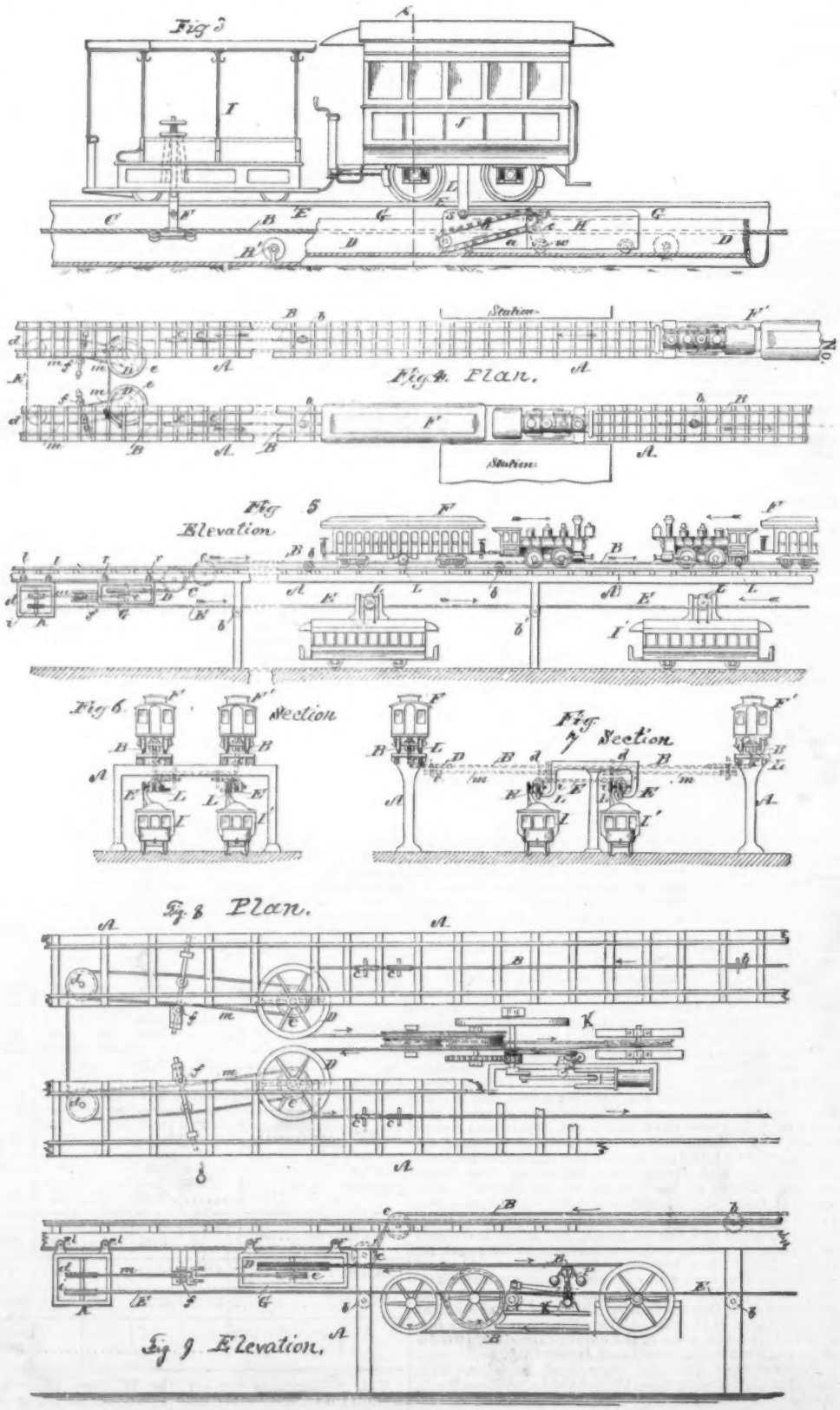


Fig. 1.





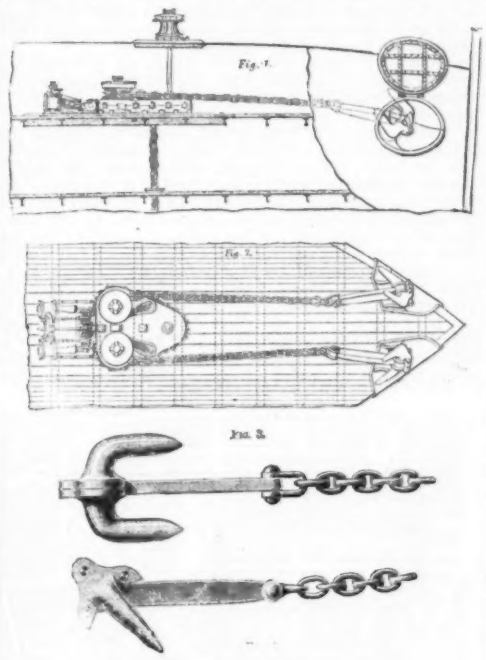
CORNING'S SYSTEM FOR CABLE RAILWAYS.

loons do not appear to have been used for military purposes until the Franco-Prussian war, where for some time communication between besieged Paris and the rest of the world was carried on by their means. The Germans had also commenced to organize a balloon force, but the war was finished before anything substantial could be done. In the United States during the civil war the Americans did some good work, both with captive and free balloons, and much skill was shown in utilizing the different directions of current at varying heights for drifting over the enemy's position and returning back to the starting point. The French military authorities are now spending considerable sums in perfecting the organization of their balloon corps, and in making experiments. In England we have during the last seven or eight years paid a good deal of attention to military ballooning, stations for the purpose having been formed at Woolwich and Chatham. Excepting that a small balloon party was sent by the Intelligence Department with Sir Charles Warren to South Africa, so far as we are aware the balloon corps of the Royal Engineers recently landed at Suakim is the first expedition of this kind ever dispatched from our shores. The balloons to be used will be inflated with hydrogen, as it has been determined, after full consideration, that this will be the most practically useful process. Mr. Coxwell, who has earned a right to be heard from his long experience, is in favor of the Montgolfier hot-air balloon on account of the ease with which the material by means of which it may be inflated can be transported. To manufacture 20,000 ft. of hydrogen or coal gas would require, according to Mr. Coxwell, about four tons of coal; by the steam and iron process, four tons of coal and two tons of iron would be necessary; while for the acid process three tons and a half of sulphuric acid and three tons of iron would be required. The hot-air balloon, however, would only give a lift of 35 lb. per 1,000 cubic feet displacement, while ordinary coal gas would raise from 40 lb. to 60 lb. per 1,000 cubic feet. Hydrogen would of course give a much higher efficiency, but, as we have seen, it is more difficult to produce. The weight of 1,000 cubic feet of hydrogen is 5·6 lb., while the corresponding weight of the atmosphere would be 80·7 lb. One thousand feet of hydrogen would therefore have a net lifting power of 75 lb., which gives about double as much as could be lifted by a Montgolfier balloon with air not heated above what is generally considered a safe temperature. Size is an element of considerable importance in military balloons, as the smaller the balloon the less material will be required in its construction, not only in actual area of material, but in strength and weight of that material. With captive balloons the advantages are more noticeable, as the resistance to the wind is much less and a lighter rope can be used. It is for these reasons that the aeronautical advisers have decided in favor of hydrogen in spite of the additional weight that it will entail on the transport department. It is stated that a balloon of 4,500 cubic feet, inflated with hydrogen, will be of sufficient size, and this can be easily managed by six hands, and may be dragged along by horses if attached to a wagon. Such a balloon would raise one man to a height of from 1,000 ft. to 2,000 ft. from the ground. The whole position of the enemy could then be surveyed, and information directly conveyed to the strategists below by means of the telephone.

For generating the gas a quantity of metal turnings and sulphuric acid will be carried but the chief source of supply is intended to be obtained from steel cylinders into which the gas will be filled under a high pressure before being sent from home.

THE CORVETTE ALEXANDRINE, OF THE GERMAN NAVY.

THE German corvette Alexandrine was launched at Kiel on Feb. 7. This vessel shows great deviations from others of its kind; as necessity demanded that greater speed should be obtained by the modern cruisers, this vessel was constructed accordingly. Of similar



BAXTER'S ANCHOR GEAR.

vessels, the Carola and Olga were launched in 1880, and the Marie and Sophie in 1881. The defects of these vessels were kept in mind in constructing the new corvette. It has a displacement of 2,370 tons, and engines of 2,400 horse power. It is built of iron and Bessemer steel, and is provided from the keel to the deck with a layer of felt and the best East Indian teak wood, outside of which another layer of planking is secured up to the water line, which planking is covered with copper. The rudder consists of an iron frame filled with wood covered with thin iron plates, on the plates teak wood is secured, and on the same a layer of copper. The screw, which has two wings, is so arranged that it can be raised so as to be out of the water when the wind is fair and the screw is not required. The deck is constructed of teak wood, as are also the hatches, etc., and the commander's bridge is made partly of teak wood, and partly of mahogany. All the guns are placed on the deck, and the armament consists of twelve 6-inch guns. The hull is divided into nine water-tight compartments by partitions, and each compartment is connected with all the pumps of the ship, so that the water can be pumped out of any one compartment in a short time.

The annexed cut, showing this new man of war, was taken from the *Illustrirte Zeitung*.

IMPROVED ANCHOR GEAR.

BAXTER'S system of working the cables, and the self-stowing of the patent anchors, is fitted on board the Imperial Brazilian armor-clad turret-ship Riachuelo.

This cable-working gear has now been fitted on board a large number of cargo and passenger steamers, some forty or fifty vessels of all classes, with the most favorable results, and the efficiency of the steel anchors and the self-stowing arrangements has been completely established. In our illustration we show the system as fitted in the S.S. Sobralense, recently built by the Barrow Shipbuilding Company, and now on her first voyage; this being a fair example of the complete system, with the latest improvements, as now arranged for vessels of her class.

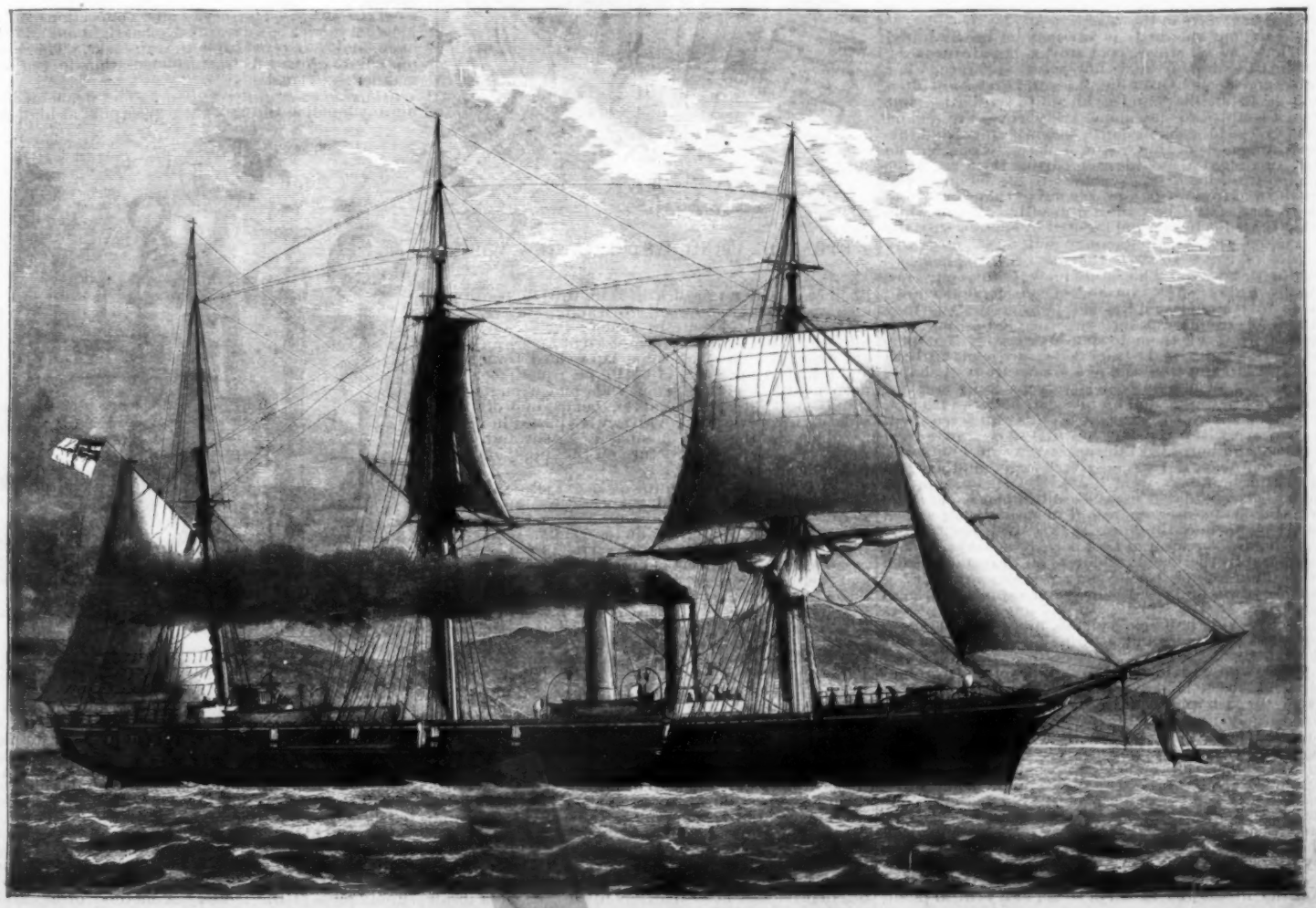
As it is unnecessary in vessels of the mercantile marine to consider the position of the driving machinery in respect to its safety from destruction from the fire of an enemy's gun, the whole of it, including the worm shafting, the bevel and toothed wheels for working the cable holders, and capstan, is in this case placed on the upper side of the deck, in a position in which all the parts are easily accessible; the working parts of the driving gear are covered by a strong iron casing, which can be readily removed without the help of skilled labor, in the event of adjustment, cleaning, or repairs being necessary. The cables are close down to, and nearly parallel to the deck; it is, therefore, obvious that the direction of the strains is nearly in a line with the deck's greatest strength.

The injurious effects of sudden and excessive strains, which the cables and hauling gear, and consequently the structure of the ship, are liable to with ordinary gearing, when the anchor is breaking ground, is with this gearing entirely avoided by the action of the friction plates within the body of the cable holders, the strains never having effect beyond a maximum, regulated at the will of the operator by a slight movement of the hand lever placed in the cap of the cable holder; and by the same means the speed of hauling in may be varied, the cable may be stopped or run out, without changing the direction or speed of the driving engine.

Both cables can be hauled in at the same time, or as the holders are vertical, and close to the deck, either of the cables can be thrown off and reversed, so that while one holder is hauling in, the other may be used for hauling cable out of the lockers, or one or both will form perfect cable stoppers by screwing the friction plates tightly down.

The shaft which works the cable holders also works the capstan, and the latter, when steam is not available, may be worked by hand, and by means of a friction clutch may be made to operate the cable holders.

The capstan is of the ordinary pattern, suitable for warping purposes, but it is fitted at the lower part with a wave drum for working a steel wire hawser. This se-



THE CORVETTE ALEXANDRINE, OF THE GERMAN NAVY.

curely grips the hawser without bruising or injuring it in any way, and has been tried at the government dockyards, where it is now preferred to the portable whelps hitherto fitted to some of her Majesty's ships.

The patent cast-steel anchors, of which we give separate illustrations (Figs. 3 and 4), are in three parts, the two arms, or fluke pieces, and the shank pieces. The fluke pieces are bolted together to form the socket for the solid trunnion at the end of the shank piece, about which the flukes work; and they also form on one side or the other of the shank piece, as the anchor may happen to fall, the spur by which the flukes are forced to enter and securely grip the ground, or the stop against the shank piece when the flukes have reached the proper angle.

It has been proved by actual experience that in whatever way these anchors take the ground, the flukes are certain, by the action of the spur pieces, to be tripped into the proper position for biting as soon as the strain comes on them. The grip is the more secure and firm as the strain is increased, and it is found impossible by any twisting strain to make the anchor lose its hold until the shank is brought into a vertical position in the operation of lifting.

The arrangement for the self-stowing of the anchors in this vessel is almost precisely the same as in the Riachuelo, and may be described as a cast-iron pipe enlarged at the outer part to form at the lower edge the bolster, or thick flange which takes the chafe of the cable. Over this the shank of the anchor is drawn and canted into position for stowing when it is being hauled with the cable into the inner part, corresponding to an ordinary hawse pipe. This enlarged part is sufficiently recessed to form a bed or seating on which the crown of the anchor rests, the flukes always turning upward and filling the space at the upper part of the enlargement. The anchor, when hauled close up, is completely and snugly housed within the outer surface of the bow plating of the vessel, and the whole is then covered by an iron lid or buckler which hinges down over it. There is no doubt that this part of the system is the natural outcome of the patent stockless anchor, the general form of which lends itself so readily to its development, and as a consequence, the catheads and fish davits and other cumbersome and expensive appliances of the ordinary system are entirely dispensed with.

It can also be readily understood that a great saving of time is effected both in raising and letting go, as the anchor is ready to let go at any moment by releasing the friction plates in the cable holders. The advantages of this great saving of time cannot well be overrated, as collisions may often be avoided, and the very safety of the ship may at times depend upon the promptness with which these operations are performed; and last, but not least, there is no necessity for swinging a seaman over the bow to fish hold of the flukes of the anchor, as is often done with the ordinary gear, and by which many have been maimed for life or washed overboard and drowned. As these advantages in economy of time and money, and greater safety, become more generally known, Baxter's system cannot fail to become popular.—*Engineering.*

HEATING BUILDINGS BY STEAM FROM A CENTRAL SOURCE.*

By Mr. J. H. BARTLETT, M. Inst. M.E.

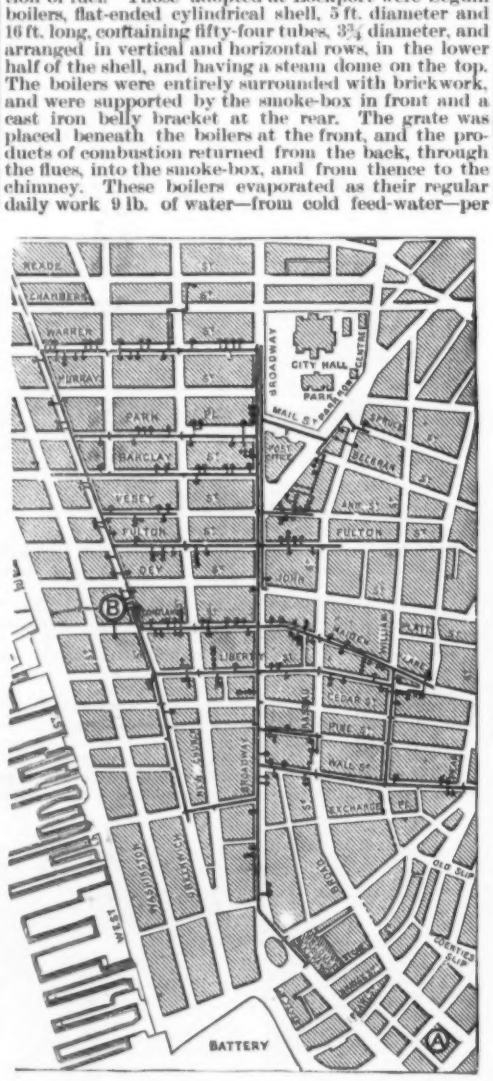
THE winter climate in a large portion of the United States and Canada is so continuous and severe that efficient means are required for raising the temperature, in all descriptions of dwelling houses, for over two hundred days in the year.

The ordinary methods in use may be briefly stated as follows: Wood stoves, coal stoves, hot-air furnaces, combination hot-air and hot-water apparatus, hot water, and steam. Open fireplaces and grates are often used as an auxiliary and as an aid to ventilation, but are not adapted for use alone. Gas stoves are seldom used, except for cooking purposes. All stoves and furnaces are made of thin cast iron plates. Considerable skill is required in moulding and fitting them up. After being in use for a time, exposed to the action of the fire, the cast iron warps and gets out of shape, allowing gas to escape, and becoming unhealthy; the air while being heated is burnt and vitiated by contact with the hot metal plates. A necessary but most unsightly feature of every stove is the flue or stove pipe, connecting the stove and house chimney. Stove pipes are usually made of sheet iron and of considerable length, so as to economize all the heat possible; but, as they cannot be swept or cleaned out when in position, it is necessary to take them down every year for that purpose. Hot water and steam boilers are made of both cast and wrought iron, and of a great variety of shapes and sizes. Anthracite coal is very generally used for household purposes, and for all small boilers, furnaces, or stoves an expensive class of this coal is required, and in every case the fuel has first to be stored, then handled and burnt, and the ashes afterward removed. Prior to the year 1877 many very large buildings and blocks of buildings were heated by steam supplied from boilers situated in some central place, and there are also many cases on record of steam being carried very long distances in pipes. In 1876 Mr. Birdsill Holly, a mechanical engineer of Lockport, New York, made a number of experiments and tests on the condensation of steam in iron pipes, and suggested the possibility of heating towns and cities with steam supplied through pipes laid in the streets. In 1877 an experiment was made by laying half a mile of 3 in. pipe; this was again increased to a mile and a third, and experiments carried on.

Before winter set in about three miles of underground pipe had been laid, and over twenty dwelling houses fitted up with pipes and radiators, and this number was largely increased during the winter; steam was supplied from three boilers situated in a central position, and carrying a pressure of 25 lb. to 30 lb. per square inch. As all the houses to which steam had been supplied during the winter had been most comfortably heated, and the discomforts of the old methods done away with, the new system created a considerable amount of interest, particularly when it was claimed that heat could be supplied at a much lower cost than by the old methods.

Description of Holly's district system.—The system consists in the generation of steam at a central point, its transmission by well protected mains to suitable distances, and its utilization for heat or power, by means of various mechanical devices. Steam is supplied to the consumer in the same manner as gas, and is paid for in proportion to the amount used, as indicated by a meter, at a cost not exceeding the usual cost for coal. As in the case of gas supply, the steam supply pipes are laid up to the curbstone, the consumer paying for all internal pipes, fittings, and radiators, which can be furnished at about half the usual charges, as a house boiler is not required. Where buildings are already fitted up, steam is taken direct from the mains, and the house boiler cut off. Where houses are supplied with a furnace, it is only necessary to substitute steam coils in its place for heating the air, no changes being required in the flues or registers.

Apparatus required.—The steam is generated in boilers centrally located with regard to minimum distance of transmission to consumers, convenience of procuring fuel and water, and cost of site. The form of boilers should be such as will secure the largest possible evaporation with the most economical description of fuel. Those adopted at Lockport were Seguin boilers, flat-ended cylindrical shell, 5 ft. diameter and 16 ft. long, containing fifty-four tubes, 3¾ diameter, and arranged in vertical and horizontal rows, in the lower half of the shell, and having a steam dome on the top. The boilers were entirely surrounded with brickwork, and were supported by the smoke-box in front and a cast iron belly bracket at the rear. The grate was placed beneath the boilers at the front, and the products of combustion returned from the back, through the flues, into the smoke-box, and from thence to the chimney. These boilers evaporated as their regular daily work 9 lb. of water—from cold feed-water—per



STEAM HEATING SYSTEM IN NEW YORK.

lb. of coal, with a pressure of 25 lb. to 30 lb. per square inch, using anthracite coal, stove and grate size.

Street mains.—From the boilers the steam passed into the mains, which are composed of American standard wrought iron steam pipe, lap welded, from 1¼ up, and tested to a pressure of 500 lb. per square inch, connected with tapering screw ends and wrought iron couplings. For special curves, bends, and other details, cast iron was used. Valves were placed in various positions, in the same manner as in gas and waterworks, so as to be able to turn off the supply of steam wherever necessary.

Protection against condensation.—This is the vital point of the system, and condensation was guarded against in two ways—first, by protecting the pipes by non-conducting materials; and secondly, by keeping them dry when underground. The pipes were prepared as follows: The naked pipes were held in a lathe, and were wrapped with the following materials: (1) Sheet asbestos about ¼ in. thick, one thickness. (2) Porous felt paper, two or three thicknesses, or hair felt ½ in. thick. (3) Manila paper, one thickness—sufficiently strong to stand handling covered pipes, and not to tear. (4) Wooden strips about ⅜ in. broad by ⅜ in. thick. Three or four of these strips were laid slightly spirally around the pipe, forming spacing pieces. Copper wire was used to bind the strips, and string for the other coverings. The outside casing of all was made of solid square pine logs, bored out about 2 in. larger than the diameter of the pipe, the thickness of the wooden shell being in no place less than 3 in. or 4 in.; the ends of the wooden pipes were made to fit into each other. When the iron pipes, duly protected, were put inside the wooden log, the spacing pieces left an air space all round, and allowed the iron pipe to expand and contract freely, by changes of temperature, while the logs were securely anchored and immovable. (In the system at Belleville, Ill., the mains were not wrapped at all, but dependence made entirely upon air spaces inside wooden casings.) Keeping the pipe casings dry, when underground, was effected by placing a tile drain, 3 in. or 4 in. in diameter, at the bottom of the trenches, which were from 3 ft. to 4 ft. deep, and conformed to the level of the street; connections were made with the city sewers as often as possible; broken stone was filled in at the bottom round the tile, and a covering of tarred roofing felt put over the wooden casing, and the trench filled in.

Expansion joints.—To provide for contraction and expansion in the iron pipes, caused by differences in temperature, stuffing-box joints were provided, and asbestos fiber used as packing. The expansion joints formed a part of the junction service boxes, which were placed at convenient intervals of from 100 ft. to 200 ft. along the line of mains, and were accessible from the

FIG 1.

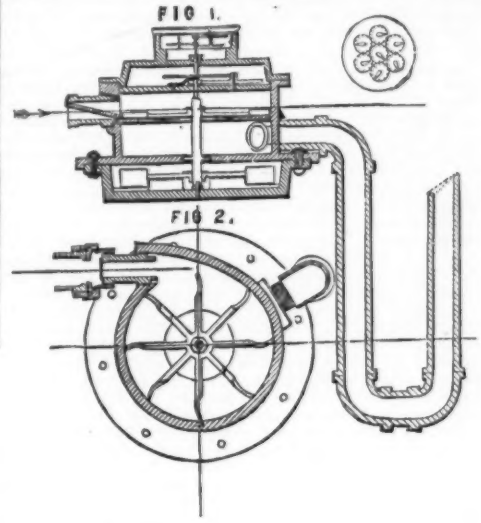


FIG 2.

THE STEAM METER.

street, being surrounded by a brick wall, and having a manhole and cover. The arriving main from the boilers had a turned and nickel-plated end, which worked through the stuffing-box. The departing main was securely fastened to the junction service box, so that, one end of each section being fast and the other movable, free play was given for contraction and expansion. A ball and socket joint attachment was always used, so as to be able to conform to variations in the levels of the streets and to prevent injury or strain from settling. The junction service box has a heavy casting, weighing several hundred pounds for the large sizes. It was bolted to brickwork, and anchored to the wooden pipe casing. The mains were never tapped for the attachment of service pipes, these connections being only made at the junction boxes, which also served to take up the water of condensation, the bottom of the box being placed lower than the level of the pipes. A very important improvement has recently been made by using elastic copper ends to the sections of iron mains; this allows sufficient play, and does away with all packed joints, which are now entirely discarded.

Service pipes.—The service pipe connections on the junction service box were taken off at right angles to the main, and were provided with stop cocks. The service pipes were protected from condensation in the same manner as the mains.

Reducing valve and regulator.—The steam on entering any building through the service pipe, at high pres-

THE REDUCING VALVE.

sure, had at once to pass through a regulator reducing valve, by means of which the pressure was reduced to any desired amount, and the supply of steam automatically regulated. This was done by means of an elastic diaphragm and a weighted lever, a small slide valve being moved by a valve rod connected with the diaphragm. Valves made on the same principle have often been used for supplying low pressure steam engines from high pressure boilers.

Meter.—From the reducing valve and regulator, the steam at a low and uniform pressure—generally from 2 lb. to 5 lb.—passed through the meter and into the supply pipes of the house. A method of accurately measuring and recording the amount of steam supplied has been a most difficult problem to solve, the

* British Association, Section G.

commercial success of the system being really dependent upon it. The method at present employed is pronounced reliable and satisfactory by several independent parties, after being in practical use for the past two years. The meter is made of cast iron, and in plan is circular in shape; its height and diameter are about equal; it is divided horizontally into four chambers or compartments. On the outside upturned face are a series of horizontal dials, which register revolutions, actuated from gear wheels inside the top chamber; they derive their motion from a central vertical shaft, passing through the other compartments, and having a bearing on the bottom of the meter. To this shaft are fastened two miniature brass paddle wheels, or spider frames, of eight arms each, with vane-shaped ends, curved slightly forward. The second or steam entry compartment contains one paddle wheel, which revolves almost touching the bottom. A circular opening in the bottom connects the third or steam exit compartment. The bottom compartment, which is closed all but a small hole round the shaft, contains the other paddle-wheel, and is always full of condensed water, in which the paddle-wheel revolves, stationary vanes preventing the water from being bodily whirled in the direction of rotation. Steam is admitted through a square pipe, the center line of the opening being on the line of the inside circumference of the chamber, giving the steam a circular motion as it enters; within, and from the top of the square pipe, is hung a long copper tongue, the same width as the pipe. The tongue rises and falls as the quantity of passing steam varies, but always directs it upon the vane-shaped ends of the spider, which revolves in the steam at a speed proportional to the amount and pressure of the steam admitted. The bottom spider, revolving in water, acts as a governor and prevents the too rapid revolution of the shaft, the revolutions of which are recorded by the counters on the top. The steam passes out of the third compartment, the exit being nearly at right angles to the entrance. The quantity of steam passing through the meter is not measured or recorded in any ordinary terms of measurement, such as pounds or cubic feet, but in "units," the value of which have been determined by experiments, the amount of condensed water resulting from steam passed through having been accurately weighed. Charges for steam supplied through meters are made per 1,000 units. The value of the unit varies with the size of the meter, the pressure of steam, and the cost of fuel and water, and the evaporative performance.

Direct heating—Radiators.—From the meter the steam intended for heating purposes passes through the supply pipes into the radiators. Any of the ordinary forms may be used, and all the ordinary steam fixtures. The usual American pattern of radiators is made of vertical lengths of 1 in. iron pipe, secured into a base and cap, the steam exit and entrance both being in the base. In common with most descriptions of steam radiators, they have to be either full of steam or empty, there being no means of regulating the steam supply. Mr. Holly overcame this by making the steam entrance at the top of the tubes, in the cap, and having an air valve at the base to permit the air to escape. Steam, being lighter than air, displaced it to any extent that might be required, entirely or only partially filling the tubes. In practice it was found difficult to keep the joints tight in the base and cap, owing to unequal expansion and contraction.

Indirect heating—by coils in the basement.—The steam and water of condensation from all the radiators passed through coils of steam pipe in a chamber in the basement, to which fresh air from the outside was carried through a flue; the air thus heated rises through flues and registers, in the ordinary way, and supplies fresh air, while assisting to heat the house.

Traps.—The water of condensation escaped through a steam trap and wasted into the sewers, unless required for domestic purposes.

Other uses of steam.—Live steam can be used for heating water, and when this is done by direct contact, the noise can be almost entirely stopped by first passing the steam through a small box filled with gravel or fragments of stone. For cooking purposes, steam does well for a variety of articles, and a stove has been perfected that, with superheated steam, all sorts of cooking can be done, the superheating being done with a gas flame. The following report of Mr. Birdsill Holly was published at Lockport on May 18, 1878: "During the past winter an equivalent of sixty-five houses,* on nearly three miles of underground pipe, has been heated, and an accurate record has been kept from day to day of the amount of coal consumed. From well understood facts, and from tests actually made to ascertain the amount of condensation in the houses, also twelve hour tests upon the main line with all the houses shut off, it is demonstrated what amount of condensation is due to the buildings and how much to the pipe under ground. The details for cost of constructing works and the cost of fuel are applicable to this city, and will be varied somewhat, according to location and circumstances. The tables given below show the cost of heating by this system, and the comparisons made with other systems of heating will, upon perusal, speak for themselves.

This result has not as yet been realized in actual practice, but none of the systems has had so large a number of consumers on so short a main.

The winter's experiment at Lockport in 1877–78 having proved the practicability of the system, and the consumers being so well satisfied, several other towns at once took the matter up, and had systems in operation for the following winter. The first meters did not work well, and the only way of charging for heat was by bargain, based upon the previous coal bills of the consumer. The companies suffered severely in these bargains, but the greatest loss was caused by having long lines of main, with only a few consumers drawing steam, the loss by condensation being then very great. In many cases the trenches were not properly drained, and the system was adopted before sufficient time had been given to perfect all details, the result of all this being the failure of several of the companies.

Duplex system at Lynn, Mass.—At Lynn, Mass., a duplex system was put in for first supplying high pressure steam through one main to drive large mill engines, these engines exhausting into a low pressure main, from which steam was supplied for heating, etc. The idea was to utilize the power first and leave sufficient pressure for heating and cooking purposes. The boiler house here was situated on very low land, which was subject to inundation during extreme high tides, the consequence being that near the boiler house the steam mains were sometimes under water; and as few of the streets in Lynn are sewered, the ground was constantly damp in many of them, and a very large amount of condensation took place. The steam supply was discontinued, and the works sold and utilized for other purposes, although the steam works were fully paying expenses at the time of selling out.

The system in New York.—In New York, the system is being operated on a very large scale by a company who have selected and purchased ten sites for steam stations. The first station—station B—at Nos. 172 and 176 Greenwich Street, has been built, and consists of a building 75 ft. front by 120 ft. in depth and 120 ft. high, in which are to be placed sixty-four Babcock and Wilcox sectional boilers of 250 horse power each, or, in all, 16,000 horse power distributed upon four floors, sixteen boilers on each floor. The draught for the furnaces of the boilers will be obtained by two large chimney stacks, each about 225 ft. high, supplemented by a fan blower on each floor. The walls of the building are 36 in. thick at their base and those of the chimneys are 4 ft. thick. The dimensions of the chimney are as follows: Exterior dimension at the base, 32½ ft. by 20 ft.; at the bottom of flue, 32½ ft. by 13 ft.; interior area, 27 ft. 10 in. by 8 ft. 4 in. The coal supply will be elevated to the upper stories of the building and delivered through chutes alongside each boiler, while the ashes will be taken by chutes from each boiler through the basement of the building. On the 1st of January, 1884, the company had five miles of its street steam system in active use, having increased from one mile in use on the first of June, 1882. The mains, which are from six feet to ten feet underground, have been all the time under a full pressure of 80 lb. per square inch, and no one has been injured. The mains are made of lap-welded tubes, and are most of them 11 in., 13 in., 15 in., and 16 in. in diameter; some are shortly to be put in 20 in. and 24 in. in diameter. In place of being screw coupled they are flanged and bolted together, the end of the wrought iron pipe being expanded into the flange by an enormous tube-expanding machine. The condensed water is returned to the boilers by a pipe about half the size of the mains. The mains and return pipe are laid in a well drained brick chamber packed all round with mineral or slag wool as a non-conductor. Expansion and contraction is provided for by using elastic copper ends to the pipes, and the details of the system have been very carefully worked out.

Number.	City.	State or Province.	Year commenced.	Amount of capital or capital stock.	Boilers. Number.	Diameter.	Length.	Number of tubes.	Diameter of tubes.	Total horse power.	Pressure carried.	Underground Steam Mains. 2·00	2·50	4·00	7·20	11·21	19·49	29·11	49·56	79·65	99·20	149·9	American Standard Wrought Iron water
				dols.								19·99	29·69	39·69	69·99	99·99	149·9	199·9	299·9	399·9	499·9	699·9	Length to contain 1 cubic foot.
												0·355	0·444	0·577	0·829	0·949	1·091	1·228	1·611	2·010	2·291	2·909	Length per sq. ft. sur. in ft.
												19·730	0·635	0·625	0·503	0·5	0·5	0·375	0·333	1·20	1·050	1·215	Actual outside diam. in ins.
												19·619	7·981	0·065	0·945	4·029	3·907	2·468	2·067	1·611	1·380	1·049	" inside " "
						10in.	8in.	6in.	5in.	4in.	3½in.	3in.	1¼in.	1in.									Nominal diameter.
1	Lockport	N.Y.	1877	30,000	6	5	16	54	2½	400	25–50	—	Four miles 8in. and under										35,170 lobal lineal feet.
2	Detroit	Mich.	1878	61,750	—	5	16	—	—	1000	"	—	About 2 miles of all sizes, 6in. and under										15,840 " " "
3	Springfield	Mass.	"	50,000	6	5	16	—	4	625	"	—	600	and 10,600 lineal feet of smaller sizes.										16,750
4	Auburn	N.Y.	"	31,000	4	5	15	72	2½	240	"	—	—	900,	1200,	—	1500,	2000,'	Not counting laterals			—	6,000
5	Milwaukie	Wis.	1879	75,000	17	5	15	—	—	—	—	185,	2340	5150,	1275,	1050,	1300,	and	6000	feet of	smaller	sizes	25,051
6	Troy	N.Y.	"	75,000	6	—	—	—	—	700	25–50	—	Five miles from 8 to 16in.				—	—	—	—	—	—	26,400
7	London	Ont.	"	60,000	6	—	—	—	—	—	—	—	—	1000,	2000,	2000,	3000,	1000,	2500,	10,000	—	—	23,000
8	Belleville	Ill.	"	40,000	10	—	—	—	—	—	—	—	Two miles 6in. and under				—	—	—	—	—	—	10,560
9	Dubuque	Iowa	"	60,000	—	—	—	—	—	—	—	—	—	800,	1200,	2000,	4e01,	—	200,	2000,	2500,	600	16,000
10	New Haven	Ct.	"	50,000	6	—	—	—	—	450	25–30	—	—	—	—	—	—	—	—	—	—	—	—
11	Lynn	Mass.	1880	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12	Denver	Col.	"	100,000	15	5	17	48	4	1100	25–30	—	1540,	4000,	—	6014,	2400,	800,	2400,	1000,	1000,	160	30,000
13	New York City	N.Y.	"	9,000,000	Ba	boo	ck	&	Wil	cox,	60	Five miles mostly 11, 13, 15, and 16in. diameter.											15,000
14	Garden City	N.Y.	"	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15	Hartford	Ct.	"	75,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16	Burlington	Iowa	"	60,000	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	Clearfield	Pa.	1880	15,000	2	6½	17	72	4	—	25–30	—	—	—	600,	2200,	2000,	—	—	not counting laterals			5,000
18	Phillipsburg	Pa.	"	20,000	2	—	—	—	—	300	—	—	—	—	200,	4000,	3000,	—	200	not counting laterals			7,000

Number.	City.	Consumers. Number.	Cubic feet of space heated.	No. of engines.	Charges for steam. Holly meters per 1000 units. 10s.	12½s.	20s.	Fuel. Description.	Amount.	Reported benefit from heating gas, lead joints, accidents.	Reported or estimated loss by condensation.	Public opinion. Are consumers satisfied?	Remarks.
					c.	dols.	dols.						
1	Lockport	300	—	—	60	2.00	3.00	Soft slack	—	None	5 per cent.	Thoroughly	—
2	Detroit	—	—	—	Usually			"	—	More or less	Very much less	Yes	Not likely to prove a good investment.
3	Springfield	194	—	—	70	—	—	Pea, dust, coke, buckwheat	4000 tons per year	None	10 per cent.	Very much pleased	Their bills are reasonable compared with former heat. The company made 14 p. c. last season.
4	Auburn	140	3,000,000	—	No regular rate.			Cleirfield bit.	2000 "	Not more than could be expected	Big	Very much pleased	Prospects good for the future.
5	Milwaukie	100	5,000,000	10	Usually		4.00	Soft slack	The company	failed during the	second season	and the works	were sold.
6	Troy	—	4,000,000	21	—	—	—	—	" "	" "	" "	" "	"
7	London	160	—	—	—	—	—	Oil and tar	" "	" "	" "	" "	"
8	Belleville	90	—	—	—	—	—	Soft coal	1000 bushels per day	None	—	Yes	No dividends paid so far.
9	Dubuque	100	3,500,000	—	—	—	—	—	—	—	10 per cent.	"	—
10	New Haven	75	—	—	—	—	—	Pea coal	—	Yes	20 per cent.	—	"Sunk all their capital and shut down for good; in other words, busted."
11	Lynn	—	—	—	—	—	—	—	—	—	—	—	—
12	Denver	140	3,000,000	—	—	—	—	Black coal	90 tons per day	None	15 per cent.	Yes	Prospects for the future good.
13	New York	250	—	100	—	—	—	Hard coal	—	"	Same as gas	"	" " " "
14	Garden City	—	—	—	—	—	—	—	—	—	—	—	No information obtainable.
15	Hartford	—	—	—	—	—	—	—	—	—	—	—	Reported to have lost money last season.
16	Burlington	—	—	—	—	—	—	—	—	—	—	—	Prospects improving.
17	Clearfield	62	1,500,000	—	50	1.50	4.00	—	—	—	—	—	—
18	Phillipsburg	75	2,000,000	—	75	—	—	Soft coal	4 tons per day	None	5 per cent.	Perfectly	Made 6 p. c. last season, and expects 10 to 12 p. c. in future.
								"	75 " "	"	5 per cent.	"	Company doing well.

* 12,000 cubic feet of space being taken as an average for dwelling houses in Lockport.

Estimated Cost of Construction and Operation for a District of 400 Dwellings on Two Miles of Street Mains, heating the same for 240 days, from September 15 to May 15.

CONSTRUCTION OF WORKS.

	£.	s.	d.
Boiler house and chimney stack	1232	17	6½
Six boilers, 5 ft. by 16 ft., set, with feed-water heaters	2465	15	1
Two miles mains, average 3 in., at 5s. 9d. per foot	3037	16	2
Superintendence and incidentals	249	17	3
Total	6986	6	0½

OPERATING EXPENSES FOR 240 DAYS.

	£.	s.	d.
2,000 tons of coal, at 16s. 5½d	1643	16	8½
Two firemen and extra labor	164	7	8
Repairs and depreciation	164	7	8
Office expenses	308	4	4½
Taxes	82	3	10
Water bill	20	10	11½
Dividend of 20 per cent. on $34,000	1397	5	2½
Total	3780	16	5
400 consumers at £9 9s. 0½d	3780	16	5

Cost of a District equivalent to 1,000 Dwellings, partly composed of Business Blocks and Public Buildings.

CONSTRUCTION OF WORKS.

	£.	s.	d.
Boiler house and chimney stack	1643	16	8½
Twelve boilers, 5 ft. by 16 ft., set, with feed-water heaters	4931	10	5
Four miles of mains, average 3 in., at 5s. 9d. per foot	6075	12	7½
Superintendence and incidentals	499	14	6
Total	13,150	14	2

YEARLY EXPENSES, HEATING, 240 DAYS.

	£.	s.	d.
5,000 tons of coal at 16s. 5½d. per ton	4109	11	9½
Fireman and extra labor	410	19	2½
Repairs and depreciation, and sinking fund	410	19	2½
Office expenses	308	4	4½
Taxes	246	11	6
Water bill	61	12	10½
Dividend of 20 per cent. on $64,000	2630	2	9
Total	8178	1	8½
1,000 consumers at £8 3s. 6½d	8178	1	8½

Statement of Cost.

INDIVIDUAL FURNACE SYSTEM.

One furnace will cost £56 10s. 1d.

	£.	s.	d.
One consumer will use 10 tons, at $5.00	10	5	5¾
Depreciation and repairs, 10 per cent. on $275	5	13	0¼
Five cents=2½d. per day for attendance	2	9	3¾
Interest, 7 per cent. on investment, $275	3	19	1¼
Unreduced insurance	1	0	6½
Total	23	7	5½

INDIVIDUAL STEAM SYSTEM.

One boiler and fixtures will cost £164 7s. 8d. Running Expenses.

	£.	s.	d.
Twelve tons of coal, at $5.00	12	6	7
Depreciation and repairs, 5 per cent. on $800	8	4	4½
Fifteen cents=7½d. per day for attendance	7	7	11¼
Seven per cent. interest on investment	11	10	1½
Unreduced insurance	1	0	6½
Total	40	9	7

DISTRICT SYSTEM WITH 400 CONSUMERS.

	£.	s.	d.
Seven per cent. interest on cost of fixtures=£41 1s. 11d	2	17	6½
Two per cent. depreciation and repairs	0	16	5¼
Heat bills, for steam supplied	9	9	0½
Total	13	3	0¼

DISTRICT SYSTEM WITH 1,000 CONSUMERS.

	£.	s.	d.
Seven per cent. interest on cost of fixtures=$200	2	17	6½
Two per cent. depreciation and repairs	0	16	5¼
Heat bills, for steam supplied	8	3	6½
Total	11	17	6¼

COMPARISON OF COST.

	£.	s.	d.
Individual furnace system	23	7	5½
Individual steam system	40	9	7
District system with 400 consumers	13	3	0¼
District system with 1,000 consumers	11	17	6¼

In a recent report the company state that they have over 200 buildings on their line, including 160 engines for power, and that they supply the steam for running the engines of the *Times*, the *World*, *Commercial Advertiser*, the *Tribune*, and five other newspapers, and a large number of printing offices, the new Produce Exchange with nine elevators and electric lights, etc. etc., and that none of these buildings have boilers on the premises. They go on to say: "To mention one thing in detail, cooking may sound small; it is and will be, in fact, one of the very largest in its consumption of steam. . . . There is one restaurant which has used our steam for eighteen months, Messrs. Smith & McNeil, Greenwich Street, and which buys from this company $15,000 worth of steam per annum. This is probably the largest restaurant in the world, serving about ten thousand meals per day. Messrs. Nash & Crook, in the *New York Times* building, is the next in size in the city, and one of the best known. The proprietors of both these immense establishments say they would not go back to their former mode of cooking if the coal were furnished to them for nothing." Steam will be supplied to heat buildings, supply power for cooking and laundry work, for baths, and many other purposes requiring water as well as steam, for melting snow in the streets, and for extinguishing fires. Steam will be supplied by meter. The system is expected to spread all over the city, and the company say that, although having been so short a time in operation, they have reached a paying basis. The most recent development in connection with the New York system is that of supplying steam for electric lighting purposes. It was found that there was comparatively very little demand from six o'clock at night until six o'clock in the morning, and there was consequently a waste in blowing it off every evening. To prevent this waste, the company propose to supply steam for running electric light engines during the night, and the cost of lighting should be much reduced in consequence. To prevent misunderstanding, it might be well to mention that there was another company in New York, which laid pipes in the streets, on some other system, for the supply of steam, but this company failed after having repeated accidents and explosions in the streets. The annexed list gives particulars of very nearly all the systems put in, the data in most cases having been kindly furnished by the companies themselves or from published reports. At Springfield, Mass., the gas company there took the matter up in 1878, and have been successful from the start, having utilized waste heat from their retorts, and also coke made on the premises. They put in a very short line to commence with, gradually extending it as consumers increased. Most of the systems are in operation for seven months, and at Denver eight months, out of the twelve. At first the street mains were only laid from 3 ft. to 3 ft. 6 in. under the ground, but it is now thought that this is not deep enough, and double this distance is recommended, so that the frost and snow will not increase the condensation.

In conclusion, it appears as if with the past experience, gained at the expense of several failures, this system of heating will in the future be adopted in many places; the two last systems reporting commercial success after being in operation only one winter.

THE THERMOMICROPHONE.

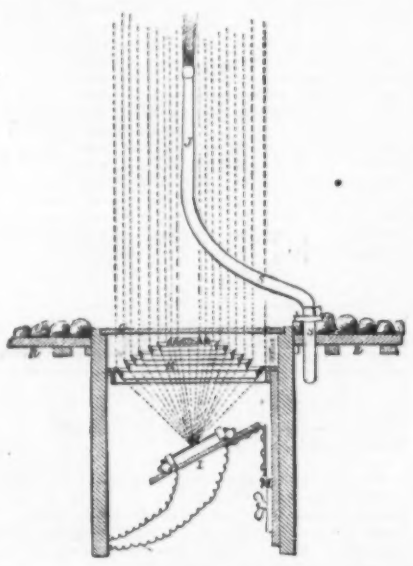
THE new microtelephonic system of Dr. Ochorowicz is composed of two instruments which, in a paper read during the past month before the Societe Internationale des Electriciens, were thus described: The magnetic receiver differs from all other apparatus of its kind: (1) By the employ of two vibrating plates equally polarized by the same magnet, and embracing the two extremities of the coils; (2) by the mode of attachment of the telephone case, which, instead of being immobile, also vibrates, and is fixed only by means of the second vibrating plate. An examination in detail demonstrates the perfect utilization of the magnetic field and the absolute concordance of the vibrations of every part of the system.

The thermomicrophone is, it is averred, the most powerful of all the telephonic transmitters. It reproduces sound in a loud tone, even when the speaker is to some degree distant from the instrument, while music and song can be so transmitted as to be heard by a large assemblage of people. The microphones with which we are acquainted may be classified as follows: (1) The Edison, which embraces all the transmitters acting by *pressure;* (2) and the Hughes, comprising all those which act by means of vibrations, and which have always a certain number of carbons, variously disposed. The thermomicrophone occupies an intermediate place, being acted upon partly by vibrations and partly by pressure. The principal feature of the system, however, is the introduction of heat. Generally speaking, all microphones are more or less heated during action, and the thermal effect increases their sensibility; but there is one great disadvantage attending it—the heat renders the apparatus irregular. The difficulty has been to regulate the instrument so as to allow for the generation of heat and guard against its disturbing influence. The action of the microphone is, as has been said, irregular; its resistance is then almost nothing, but from the moment that a current of 18 to 20 milliamperes passes through it, it becomes heated, its resistance augmented (to about a mean of 200 ohms), and the apparatus will be found regulated for transmission.

Under these circumstances, it is evident that the exterior temperature will assist or impede the effective working of the transmitter; but by the application of a layer of insulating material in the interior of the microphone itself, Dr. Ochorowicz has been able to maintain a temperature of from 13° to 39°, which is sufficient for all practical purposes. At the conclusion of the paper the thermomicrophone, actuated by five Leclanche cells, was placed in a room on the third floor of the building, and the receiver upon a table in the conference room some 50 meters distant. The result seems to have given great satisfaction, the articulation of the instrument being so distinct that the three hundred members of the society were enabled to hear it with perfect ease.—*Electrician.*

ILLUMINATION OF FOUNTAINS BY THE ELECTRIC LIGHT.

THE arrangements by which the central fountains at the recent Health Exhibition were illuminated from below will be understood by referring to the accompanying figure, from *Engineering*, which is rather an illustrative diagram of the method of illuminating the central fountain than a sketch of the actual apparatus employed. Immediately below the nozzle, J, of the central jet is fixed a circular plate of glass, G G, which forms a water-tight window in the roof, R R, of the chamber under the island, and below this, and co-axial with the jet, is fixed a sixth order cata-dioptric holophote, H, about 23 in. in diameter, built up of six reflecting zones and a central Fresnel lens constructed of a middle lens surrounded by two refracting rings. The focal length of this holophote is 150 millimeters, and it condenses all



the upper rays emanating from a source of light at its focus (which lies in the plane of its outer zone) into a vertical cylindrical beam of the same diameter as the outer reflecting belt. Near the focus of this holophote is placed a simple arc lamp, L, carrying a pair of carbon rods which are regulated by hand by a simple rack and pinion adjustment; the lower pencil is one of Siemens' 18 millimeter cored carbons having a hard shell and soft core, and the upper pencil is hard carbon 16 millimeters in diameter. In this case the lower and cored carbon is the negative, in order to get the light-giving crater at the bottom. The lamp is, for this reason, set at an angle with the horizon (but not so great as that shown in the diagram), and is attached by a bracket to a sliding block of wood, while its focal adjustments can be made. The four corner jets are illuminated in a precisely similar way, except that in the place of a holophote a horizontal Fresnel lens of 20 in. in diameter is employed, the lamp and other arrangements being exactly the same as for the central fountain.

In each of the two water-towers and fitted with suitable optical apparatus are three Siemens focus-keeping lamps, each placed in such a position as to throw a concentrated beam of light through the axis of a horizontal glass tube which projects over the ornamental basin and through which a stream of water will be allowed to pass; the effect of this will be that six luminous streams of water will flow from the top of the towers into the lake below. All the lamps, both in the island and in the towers (that is to say, eleven lamps), are worked in parallel circuit from a new form of Siemens direct current machine, to which we shall refer later on, and the resistances of the lamp circuits are so balanced by means of wire and ribbon resistances (fixed in a small hut in the grounds), that the six Siemens lamps, each taking 20 amperes of current, and the five hand lamps, each taking 60 amperes, receive neither more nor less than their proper working current.

The electric light apparatus within the clock-tower consists (1) of a hand-adjustment lamp, fixed in a military holophotal projector, which is capable of being directed in different directions both in altitude and azimuth, and deriving its current from a Crompton-Burgin machine; this apparatus is fixed just above the clock face, and projects its beam through a window on to the fountains. (2) A second military projector fixed above the clock room and at the foot of Edmund's mast light. In this is a Siemens focus-keeping lamp deriving its current from a Siemens alternate current machine. (3) Two Brush focus-keeping lamps, one on each side of the clock-face, and each in the focus of a silvered parabolic reflector which can be directed to different angles of altitude and azimuth. All these lamps, as well as those on the island and in the towers, are fitted with suitable switches by which they may be thrown in or out of the circuit at any moment. Various colors and combinations of colors are given to the beams by sheets of colored glass or gelatine plates interposed in the beam in front of lenses, and the rapidly changing effects of color are produced by a set of differently colored gelatine plates drawn in succession through the path of the beam.

The electric signaling apparatus consists of a key-board of thirty-six pushes fixed in the clock-room, from whence the orders are given, and these are connected by wires with the indicating apparatus in the island and on the water-towers. This latter apparatus consists of two electric bell indicators, one for giving instructions respecting the valves, and the other for controlling the lights. The eight tablets in the "water indicator" are labeled respectively "Steady," "Red," "Green," "Blue," "White," "Black," "Center," and "Yellow," and refer to the valves which regulate the different systems of fountains, and which, as we have described, are painted with the above colors in order to readily distinguish them and to facilitate the signaling. The "Light indicator" has six tablets, labeled respectively "Center lamp," "4 Side lamps," "Blue," "Yellow," "Red," and "Green." There are besides several electric bells, one large bell labeled "On," and a smaller bell "Off," indicating that the water or the lights are to be turned on or off, the signals on the indicators showing to which it refers; and, in addition to these, there are bells of different tones for calling attention or for answering an order. The pushes on the key-board correspond of course with the tablets on the indicators, but an almost infinite number of orders can be conveyed by combining two or more signals together, and Sir Francis Bolton employs this means to indicate to the assistants in charge of the valves and lights any one of the multitudinous effects which he may at any moment desire to produce.

CONCRETE AS A BUILDING MATERIAL.*

By THOMAS POTTER.

THE reintroduction, about twenty years since, of concrete as a material for building walls received at that time considerable impetus from two causes: 1. The invention of appliances or moulds for forming the structural portions of buildings of a monolithic character. 2. The superior properties possessed by Portland cement as a matrix in place of ordinary lime. And as an important addition to our stock of building materials, concrete would undoubtedly have received more public attention, and become more generally adopted, if it had not been subjected to the fate of most inventions; for, as usual, we were told that concrete was to be the salve for every sore in building operations; there were to be no more damp walls or tumble-down walls, for it was impervious to moisture, and I don't know how many times as strong as any brickwork. Mechanics would be no longer needed, for the appliances could be fixed and the work executed by any ordinary laborers; while its cost was less than one-half that of the commonest specimen of brick walling.

Many other improbable statements of a similar character were made public, one enthusiastic concrete builder offering in a trade journal to prove, or otherwise to forfeit a considerable sum of money, that concrete was ten times stronger than any other building material; while, on the other hand, a concrete building in course of erection by the same individual soon after collapsed without any apparent cause whatever. But the remedy for all this clap-trap was simply a question of time, and, as a matter of course, we do not now hear such extraordinary statements as these put forth. Concrete is now simply recognized as an important addition to our building materials, and a valuable factor in construction under certain conditions, and its employment for many purposes in connection with building is perhaps more extensive and more varied than many are aware of. Its introduction as a wall-building material served a good purpose in certain ways.

For example, previous to then, little care or trouble was taken in many instances about the concrete used in foundations, the fact being that no means existed to test its quality or strength after it was buried in the trenches dug for its reception. The usual formula of a certain proportion of Dorking lime and Thames ballast, to be well mixed and thrown in trenches from a certain height, was the sum and substance of many specifications for ordinary buildings, and in some instances is so even now. But the quality of the concrete used in foundations is equally as important a matter as if the walls themselves were to be constructed of the same materials, especially with buildings of considerable altitude, or where the ground is of a treacherous character. The knowledge gained from experience of the immense strength possessed by good concrete has engendered various considerations in connection with the ordinary system of executing foundations and footings of walls; for instance, assuming that the concrete in foundations is of first-class character, it is submitted whether brickwork footings which are intended to distribute the weight of the walls over a greater superficial area, and which are not calculated to be of any practical use in strengthening them laterally, are of any service whatever when the sustaining medium (the concrete) is incapable of yielding from the superincumbent load it has to bear.

And, again, whether it would not be practicable in many cases, as, for instance in clay soil, to excavate the ground of a wedge-shape section, the large end downward, reducing the thickness of the concrete at top to that of the wall itself, or somewhat more, and increasing it at bottom so as to give the foundations themselves a broader base, and thereby more correctly define, without any increase of materials, the principle of correct distribution of strength. Practically the foundations of walls should not be dependent upon the ground for lateral support; they should be strong enough to permit the soil on either side to be excavated to the bottom of foundations, if needed, after the building has been erected, and without a possibility of danger. But how many new buildings would be safe under this ordeal? The cost between good and bad concrete is so little that there is no excuse for an inferior material for foundations in any building with a claim to substantiality.

* A paper read before the Society of Architects, March 17, 1885.

There are many opinions and many delusions in connection with the apparently simple subject of "concrete"; for instance, with regard to the size of the aggregate, it is usual to specify that it shall not exceed certain dimensions, usually that each portion shall pass through a 2 in. or sometimes 1½ in. ring, and even 1 in. ring or screen is not an uncommon stipulation, whereas, in point of fact, the larger a certain portion of the aggregate may be the better the concrete, simply because the larger the particles composing the aggregate, the less superficial area to be cemented by the matrix. In other specifications it is stated that the aggregate shall be of a certain uniform size, with a fixed proportion of sharp clean sand mixed therewith. This, especially if cement is to be used as a matrix, is entirely wrong; and another plan is to instruct water to be added to a measured quantity of aggregate, and the amount of the former needed to fill up the crevices of the latter is supposed to represent the proportion of sand necessary to add to the bulk. This is a fallacious system, because the sand could not by any means occupy the minute crevices available for water.

Practically, what is required for an aggregate in good concrete, as far as size is concerned, depends upon the thickness of the foundations, or walls, or floors, or whatever purpose it is required for, and no hard and fast line can be drawn for these relative dimensions; but whatever the size of the largest, the smallest should never be finer than Thames sand. The thicker the wall or foundation, the larger a portion of the aggregate may be, because homogeneity is then rendered more easily attainable, the only limit to size being that homogeneity must be the first consideration. Approximately, it might be safe to specify for work up to 9 in. thick all that would pass through a 2½ in. ring, and above that thickness through a 3½ in. ring, conditionally that the intermediate quantities were so varied both in size and shape that, without any undue proportion of the coarse sandy element, the whole should, when subjected to gentle impingement, be rendered perfectly homogeneous. I admit that in the absence of considerable practice, it requires some judgment to fix upon this condition of materials; but approximate results could be obtained by making up samples of concrete in boxes, each holding a cubic foot, varying the proportions, and when consolidated removing the wood cases, and breaking the cubes of concrete to pieces.

The sample that was perfectly homogeneous, and which contained the least proportion of fine with the greatest proportion of coarse materials, would represent the best consistency of aggregate for insuring the largest amount of strength. And it must be self-apparent that the nearer each unit of the aggregate approached in shape to an irregular polygon, the better the particles would interlock with each other, and for this reason sea beach and river shingle never make the best aggregates; and breaking by percussion, such as by hard hammers, produces aggregates too uniform in size, and which require the fine and intermediate portions to be obtained by some other means and added thereto. Probably the best way of obtaining an aggregate suitable in size and shape, and, as a rule, possessing somewhere about the relative sizes and proportions, is to use a Blake's stone crusher. Where this is done it will be found, however, that the harder the aggregate material to be crushed, the less the proportion of fine and intermediate sizes produced, and due allowance must be made in such cases by abstracting a portion of the finer quality, or adding some obtained from other sources, as circumstances may require; usually, however, the latter is unnecessary.

Although it is customary in the neighborhood of London to employ Thames ballast for concrete, it is far from being the best material for the purpose; the harder variety of stones, hard brickbats, brick clinkers, coke, and slag, are all more suitable than flint or flinty gravel. In point of fact, old building materials are often carted away as rubbish or for road foundations which would make most excellent concrete if broken up, and Thames ballast is as often brought miles for an aggregate for the formation of concrete for new buildings to be erected on the same site. If a mass of ballast or flint concrete is broken with a sledge-hammer after complete solidification has ensued, it will be found that some portion of the gravel will show clean surfaces from want of perfect adhesion; with any of the other materials named, this is absolutely impossible if the concrete is executed under proper conditions. One of the most important factors in connection with a good aggregate is that it should be clean, and I can safely affirm that the more experience one has in the use of concrete, the greater will be the care taken to thoroughly wash the aggregate.

And this is more essential where Portland cement is used than with lime, for as matrices they essentially differ from each other in their special properties. A small proportion of fine sand may not be highly injurious in the aggregate if lime is the matrix, more especially as the proportion of the latter is usually greater than where cement is used; but with cement the case is different—it has but little affinity for any material as fine as itself, and it also possesses the strongest adhesive and cohesive properties when unmixed with sand. The usually small proportion employed also, 10 to 15 per cent., although ample to secure an excellent concrete produced under the best conditions, is insufficient to allow the presence of a quantity of deleterious foreign matter in the aggregate. If the material for aggregate is absolutely clean previous to being broken, it still requires washing afterward; for the action of percussion, say, if reduced by hand-hammers, or of compression, if reduced by a stone-crusher, produces a quantity of dusty particles. The necessity for cleaning, where no foreign matter existed previous to the reduction of the aggregate, will possibly be disputed; but it can readily be proved by mixing samples of cement with the water in which some clean broken aggregate is washed, and testing the sample in a cement-testing machine. And as the cost of washing would but rarely exceed 6 d. per cubic yard, I submit the concrete is increased much more than that amount in value by the elimination of all the dusty and fine-grained constituents of the aggregate.

With regard to the matrices employed for concrete, there is a unanimity of opinion which admits of no doubt that for strength and other qualities there is nothing to surpass good Portland cement. But poor limes of hydraulic character, such as that made from lias limestone, possess very considerable strength, and are adapted not only for concrete in foundations, but for walls themselves. It can safely be affirmed that concrete made of a suitable aggregate, and ground blue lias lime, in the proportion of one of the latter to five or six of the former, is as strong as ordinary brickwork, and can be used for walls of any description where brickwork can be employed. But there is this difference in the natures of lime and cement, that whereas with the former a fixed proportion of sand is absolutely necessary for the chemical change which converts the lime into mortar, with cement the case is the reverse; for although the sand is essential to fill up the interstices of the aggregate next above it in size, it has the effect of weakening the adhesive properties of the cement. And here we obtain one of the main contributory causes to both good and bad concrete.

Blue lias lime is supposed to attain its normal strength as a mortar when it is mixed with double its bulk of coarse sharp sand; when, therefore, the aggregate contains either more or less than this proportion of sand to lime, so is the cementitious nature of the matrix reduced, and a lime concrete composed of six parts of an aggregate to one of a matrix should therefore consist of one part of lime, two parts of coarse sand, and four parts or a coarser and irregular sized material. With cement, on the other hand, the aim is, or should be, to do with as little sand as possible, but not to risk that *sine qua non* of good concrete—homogeneity. It is a mistaken notion to suppose that lime used as a matrix will expand or "blow." It will undoubtedly do so if used directly it is ground; but it should be treated in the same way as cement, viz., spread out on a wood floor away from all damp, and not used for two or three weeks at least after having left the millstones, and there will be then no danger whetever from expansion. Nor will this cooling in any way lessen the ultimate strength of the lime, nor will it affect its setting properties so far as to render building operations tedious if employed for wall building; practically it requires about double the time of Portland cement to set or harden.

As blue lias lime is oftentimes procurable in neighborhoods where Portland cement is a costly article, it is somewhat surprising to find it so little used for concrete building; where, however, the cost of cement is not handicapped too severely by the expense of carriage, the gain in cost, all points considered, is but little. It is not an uncommon practice to employ lias lime concrete as an underpinning for walls of old buildings which have given evidence of sinking, using the lime fresh for the ostensible purpose of causing the concrete to expand, and thereby pin or wedge up the building. This I submit is wrong in principle; the lime in no way causes the aggregate in itself to expand, but forces the particles asunder, and instead of forming a dense mass, creates fragmentary blocks, whose effect is entirely at variance with the object of the concrete. If we mould a sample of concrete made with fresh lime in a box or frame, and when hardened take away the wood casing, it will sooner or later crack and split up into small portions.

The practice of "packing" concrete—that is, depositing in layers, or otherwise, bowlders of stone or similar suitable materials in the soft mass—reduces the cost, and is by no means objectionable, provided it is thoroughly incorporated with the concrete itself, and this forming a portion of the aggregate, is simply an illustration of the principle that the larger the portion of the aggregate the better—always on the understanding that perfect homogeneity must not only be aimed at, but obtained. There are some objections to concrete as a wall-building material. For instance, it has an inherent tendency to show cracks on the finished surface, especially if stuccoed to a smooth and even face with cement. All building materials, as is well known, are subject, more or less, to change of form with change of temperature; but in an ordinary way, with ordinary materials, the change is imperceptible when spread equally over the innumerable mortar joints of the materials of construction. But this decided evil in concrete is very much lessened if the cement is not used too fresh, and the work, is not hurried. I have found, too, that the time of year during which concrete work is executed has a marked difference in this respect upon the behavior of the walls; if performed during cold weather, there is but little after-evidence of contraction or expansion, while if done in hot weather these cracks seem inevitable and irremediable.

As to another objection applied to concrete, the difficulties of alterations to existing buildings, arising from the tenacious quality of the constituents, I think, is evidence in its favor, for probably no owners of property would prefer weak walls to strong ones, or, as a simile, would for such a problematical reason select brick walls built in common lime mortar to those built in cement mortar, assuming they had a choice, and the cost of each were identical. Another objection is the difficulty of suitable means for the fixing of joinery and other fittings. Wood bricks can be built in as in brickwork, but are not advisable. Wright's fixing blocks, however, are available, and superior to wood bricks, without any of their shortcomings, and at but very little cost. When a small plug is likely to be required for a single nail, such, for instance, as for narrow architraves, pieces of bell-wire tube 2 in. in length, filled with sand, can be built in, the sand being afterward withdrawn and a wood plug inserted. I might mention this is an excellent way of providing means for wiring concrete garden walls for fruit and flower trees. Concrete walls convey sound unfortunately only too well, and the better the concrete the better the conductors they become; there appears to be no remedy that I am aware of, except the ordinary and objectionable practice usual with brick walls, such as battening, covering with dry hair-felt, etc. But its greatest defect in the eyes of most people is that it is assumed to be difficult to treat artistically, and no doubt there is much to be said against concrete on this head.

Stucco is, as a rule, inadmissible now, and it is unfortunate that the introduction of concrete was, for some reasons, fifty years too late, for then the cry of sham had not taken so deep a root as now, and in many cases buildings for which it is admirably suited are built with other materials, because of the inevitable stucco. But concrete can be moulded into almost any shape or size, and dyed to any permanent color, and it is difficult to know why it should not be as much recognized as a facing and ornamental material as terra-cotta, for it has the advantage of the latter insomuch that it can be produced with absolute truth of form, which, with terra-cotta, appears to be out of the question. The specimens of concrete work produced by Messrs. Lascelles and others are equal in workmanship and appearance to carved stone or cut brickwork, with the advantage of being undamageable by frost, and more economical in cost. Rough-cast, pebble-dash, and other surface finishings have been introduced according to individual tastes and fancies, and for buildings in the country are very good methods of finish.

Facing slabs of concrete have also been used. Mr. Marsden, an architect of Liverpool, invented a system by which the inside and outside slabs were tied together by iron ties, and the cavity filled with concrete. Mr. Chas. Drake introduced a similar system, with the addition of dovetailed grooves cut in them to assist in securing them to the core, and I made some for a special purpose some years since, doing away with the iron ties, and using dovetailed lugs of concrete cast on the slabs themselves. This enabled walls to be built of brickwork externally, with a core of concrete, and facing slabs on the inside. Made in different colors for the inside of the walls, instead of plastering, they have been employed by the architect of the Epsom Townhall, Royal Albert Dock Hotel, and other structures, Messrs. Lascelles being the builders. It does not appear to be so easy to get any other stain for concrete except a deep red, and for which mineral oxide is a suitable medium. Stains of an earthy character deteriorate the quality of the cement, otherwise almost any variety of tint or shade is possible. I have used bullock's blood instead of water, and obtained an excellent tint and hardness of finished material; but there are obvious objections to its general use.

The question has often been raised as to the amount of water necessary for the mixing of concrete, and the general view appears to be that great care should be exercised in not applying too much; but probably too much is better than too little. Without sufficient water homogeneity and perfect cohesion are impossible; whereas if too much is used, the cement parts with all or a greater portion not required for setting. In such instances clear water may be found on the surface of the concrete in foundations, and in the case of concrete resting upon boards or centering, the clear water will pass from it through the joints of the boards in considerable quantities. With regard to the assumed expansion of Portland cement concrete, it is doubtful if any takes place; a continuous floor, 130 ft. in length, on iron girders, commenced and finished within a fortnight, never affected the end walls sufficient to disturb their perpendicular position in the smallest degree. The best use for concrete, however, is undoubtedly for floors—best because there is no other material can approach it for facility of execution, strength, and economy.

At present it may be said that the construction of concrete floors—by which I mean floors carried by iron girders or other means in contradistinction to concrete laid on the natural ground and designated paving—is almost in the hands of specialists; and although for many reasons better so than if otherwise, it greatly restricts its use for private buildings. The limit of this paper and the importance of this branch of the subject render it impossible to enter upon the question of floor construction; but there are a few general matters in connection therewith worth passing consideration. An American journal lately reported that a high authority in that country had proved that concrete was not a fire-resisting material; but we are not told what the concrete referred to was composed of. In point of fact, if the aggregate was of a flinty character, it would under a moderate test, no doubt, go to pieces; but fire-brick, hard-burnt brick, coke, or slag as aggregate, will stand the effects of a conflagration as well as ordinary brickwork. Mr. Hyatt, of Farringdon Street, some years since tested concrete beams in which iron was embedded, and after being some hours in a furnace they were found uninjured; and when tested by means of Holtzapffel's thousandth gauge, it was found that the expansion of both materials was, to all intents and purposes, the same, and that iron and concrete could be used in combination as a fireproof material without danger.

It has been usually assumed that concrete floors will withstand no vibration and sustain no deflection; but Lieut.-Colonel Seddon some years since, while conducting some experiments, proved by actual results that this theory is far from being correct; for a concrete slab under severe trial deflected without breaking to such an extent as to tilt up on the outside edges, and leave a cavity between these edges and the walls it rested upon. A number of men also jumped simultaneously upon the same slab, and although causing perceptible vibration, the slab remained perfectly sound, and a beam weighing 329 lb. dropped endways from a height of 4½ ft. on to the center of the slab had only the same effect, the concrete remaining uninjured. Mr. Hyatt also found that a beam of concrete, free at all points, bent considerably when exposed to a great heat, but returned to its normal shape when allowed to cool. Much antipathy prevails to a finished surface of cement for concrete floors and pavings of dwellings; and even for agricultural laborers' cottages, a strong feeling exists against it. This is accelerated by the cold surface of the cement inducing condensation of watery particles, in damp, changeable weather.

Where the surface can be covered with a carpet or cocoanut matting, this objection is of course removed, although wood is more generally preferred. Where circumstances permit, a perfect floor may be formed by covering with or gluing down linoleum to a smooth surface of cement for the center of rooms, and employing parquetry fastened down with Eberhard's patent glue for the borders. Provision must of course be made for the finished floor surface to be level or flush throughout, and a carpet just to cover the edges of the parquetry all around completes the arrangement. In this case the concrete and cement must be absolutely dry, or the parquetry will burst up, and the linoleum expand or wrinkle, eventually cracking or splitting as the concrete below becomes dry. For cottage and other common floors ordinary deal battens in narrow widths, and half or three-quarters of an inch in thickness, may be nailed securely and permanently to concrete made with soft bricks or coke, the ordinary sheet floor brads being well adapted to fasten the boards down with. This has been used in a number of laborers' cottages, apparently with complete success, and Mr. Hall, of Moorgate Street, treated some floors in a similar way a

year or two since for some model dwellings in the city; and possibly others may have adopted the principle as an economical system of cheap flooring, possessing very many advantages over ordinary floor joists and thick flooring boards. As in the previous case, the concrete should be thoroughly dry.

For pavings of courtyards, basements, and similar places concrete is an excellent material laid monolithically, provided there is no probability of periodical upheavings being required to examine contiguous drains; where such a possibility exists, then the paving should be of ordinary concrete slabs, such as laid down for footways by the Victoria Stone Company. This paving is an example of what can be accomplished with concrete made with the best materials and under the best conditions. Among the multitudinous articles used in buildings or in connection therewith made of concrete, may be mentioned stairs, sinks, troughs, sills, copings, pier caps, ridge tiles, and others of a similar character. For rough lintels over door and window openings it ought to quickly supersede wood; for while it is or may be made as strong as York stone, there is practically no deflection and no decay, as with timber, while in case of fire they would help to support the walls; whereas the destruction of wood lintels is oftentimes the cause of their collapse; and in addition, the cost of concrete lintels, as far as my experience goes, is always below that of good Baltic fir timber. For water tanks nothing is so suitable as concrete; it is unyielding in character and economical in cost, and many hill farms and outlying cattle sheds have of late years been supplied with excellent water collected from slate or tile roofs into concrete tanks, and which formerly depended for their supply upon the runnings from roads drained into clay ponds, and oftentimes little better than sewage.

The use of concrete, both at the present time and in the future, involves so many issues, and its application to building purposes is gradually becoming of so varied a character, that I regret limit of time has only permitted me to refer in a very brief manner to some of the more important points in connection with the subject. The various methods of building walls, the appliances in use for the purpose, and the construction of fireproof and other concrete floors are necessarily left untouched. I have endeavored simply and briefly to call attention to some of the less generally known but most vital points in connection with the production of good concrete, also to several matters of detail, and last, but not least in importance, to its faults. Having enumerated some of its good qualities, it is superessential I should acknowledge not only its shortcomings, but candidly avow them, and by calling attention thereto, leave to others an opportunity of suggesting or practicing means to remedy them.

SIXTEENTH CENTURY HELMETS AND ARMOR.

This sheet of elaborate armor of Italian and Persian workmanship includes three very choice specimens of highly-perfected design, carried out with the utmost delicacy of execution, each piece being decorated throughout in minute and appropriate ornamentation. The full suit of plate armor, first worn in Italy, was not known until about the year 1300, and in England, or even France, does not appear before several years later. At first it was, naturally, quite plain, but very soon became the fit subject for much decoration. This gradually developed from the hammered-out flutings, which usually followed the lines of the armor, till, in the reign of Henry VIII., considerable elaboration was freely introduced. The helmet and every other part of the suit was covered with embossed figures or arabesques engraved, chiseled, chased, and damascened with gold and silver; while shields and swords, especially their hilts, were often carved with very complicated subjects, more or less in bass-relief. Italy, closely followed by Germany, continued to produce the most beautiful armor, and the parade helmet from the Artillery Museum at Paris, which we herewith illustrate, of late 16th century date, is, perhaps, one of the richest examples of repousse work which could be instanced. All the ornament is dexterously beaten out with the hammer in thin sheet metal, so as to express the smallest pattern as well as indicate, as in the bolder figure work, the graceful curves and modeling of the forms introduced as centers for the rest. Towering above the crest a defiant dragon, plume-like, gives a graceful finish, and completes the whole, both in suitable proportion and scale. The Italian cuirass and helmet in repousee and engraved iron, from the collection of Napoleon III., is another instance corresponding with the last, and of the same date.—*Building News.*

Italian Parade Helmet
from the Artillery Museum Paris.

Italian Cuirass and Helmet in Repoussé and Engraved Iron
From the Collection of Napoléon III.

A patent taken out for a yellow metal, by T. Parker, describes it as of great tensile and compressive strength and hardness, and made by melting copper, 50 parts, spelter dross 25-30, spelter, 12·17, tin 2½ parts, with a flux of the following composition made into a paste: salt cake, 5 parts; coal dust, 5, silica, 15; bone ash, 20 parts. Manganese or copper sulphate, or the chlorides of these metals, and also common salt, may be used in place of the salt cake. This flux is also applicable to the founding of brass and bronze generally.

[Continued from Supplement, No. 486, page 7759.]

THE PRODUCTION OF AMMONIA FROM THE NITROGEN OF MINERALS.*

By Mr. George Beilby.

It has been shown, in what has gone before, how comparatively easily the process could be applied to the ordinary process of shale distillation: (1) Because of the small percentage of carbon left in the coke or spent shale; (2) because a current of steam was already in use in oil-making retorts, and had only to be supplemented to a moderate extent for the new process; (3) because the spent shale had at best only a very trifling value as a fuel, and was, therefore, practically a waste material.

On these accounts the extra costs involved by the process were merely nominal, so that the whole of the increased yield of ammonia was clear gain. In seeking to apply the process to new purposes many new factors are introduced. It is evident that if a gas company, turning out a good salable coke, were to proceed to spend money in converting ten shillings' worth of coke into ten shillings' worth of sulphate of ammonia, the operation would not commend itself to business men. But if, in addition to the ten shillings' worth of ammonia, a further ten shillings' worth of something else were to be obtained, the whole matter would assume a more practicable aspect.

In connection with this process the something else must be heating gas. I feel some hesitation in venturing to approach so heretical a subject as a double gas supply—for heating and lighting purposes—and have no intention of suggesting such a thing in any but a very limited sense. There is, I believe, a sense in which the realization of a double gas supply is both possible and hopeful.

In a paper read before the Mining Institute of Scotland, in September 1883, among other suggested applications was the following: That gas companies in the immediate vicinity of manufacturing towns might carbonize cheap coals or slack, selecting from the gas the portions of highest illuminating power to be purified and distributed in the ordinary course; the coke from the carbonizing retorts to be dropped into secondary retorts below, and there gasified in excess of steam, producing a large volume of heating gas and ammonia; this heating gas, after separation of the ammonia, to be distributed by large mains to manufacturers in the immediate vicinity of the gas works, to be used by them for firing steam boilers, pottery kilns, glass furnaces,

* Paper read before the Society of Arts on February 12, 1885.

forges, or metallurgical works of all kinds. In properly selected situations, these outlets for heating gas might be fairly profitable, as no excessive capital expenditure would be needed to lay down the distributing plant. The advantage to urban manufacturers of having a steady supply of smokeless fuel at the same cost per effective unit of heat as coal would be very great.

The advantages of gaseous fuel in many manufactures are so well known, that it is hardly necessary to repeat them; the cleanliness and freedom from smoke, the command of temperature, the reduction of wear and tear on brick furnaces and ovens—these are a few of the advantages.

In the face of such obvious advantages, we are, at first sight, at a loss to understand why gas firing has not made more rapid advances in public favor. As far as my opportunities have enabled me to judge, it is not because any one really doubts the excellence of the fuel, when it is once produced of the proper quality, but because the ordinary run of manufacturers are not in a position to devote to the mere preparation of their fuel the amount of care and attention which are absolutely necessary, if a steady and satisfactory product is to be obtained.

Hence we generally find that it is only in very large works, where the production of fuel gas is of sufficient magnitude to raise it to the dignity of a separate department, that satisfactory results are obtained. But in fully equipped gas works we have the chief requisites for the production of fuel gas ready to hand—skillful gas engineers, and a perfectly organized staff thoroughly familiar with the manufacture and handling of large volumes of gas.

To show that the suggestion made in 1883 contained at least some element of vitality, it is worthy of note that a somewhat similar suggestion was subsequently taken up and discussed at length in the columns of the *Journal of Gas Lighting*. This latter proposal was that fuel gas should be produced in ordinary coke generators, no other products being obtained from the coke. If such a scheme had in it the elements of success, much profitable results. Since October, 1883, there has been in constant use, at Oakbank, a small bench of retorts which produce heating gas of the composition already referred to, and equal, we estimate, to 60 per cent. of the heat energy of the coal consumed. The ammonia produced has varied from 80 lb. to 134 lb. of sulphate per ton of coal, and the present average excess of steam used is about 2,500 lb., or 250 gallons per ton. A cross section of the bench of retorts is shown in Figs. 6 and 7. The retorts are firebrick tubes of oval section, built up of grooved and tongued bricks similar to those exhibited. Each retort is self-contained, being closed at the bottom by a faced door, and at the top by a hopper and charging door. The steam and air are blown in at the upper side of the mouth piece, and pass up through the coke in the lower half of the retort. The gases pass off by an exit pipe built in about halfway down the retort proper, and are drawn through condensers and scrubbers by an exhauster. A portion of the cooled and washed gas is led back into the setting, and by its combustion maintains the whole interior at a red heat. The gas producer in front is only used in heating up the bench at first, and after the retorts are in full work it is shut off, and the firing is done by the retort gas.

When the retort is in working order, it contains in the upper part, above the exit pipe, coal in process of coking, and giving off hydrocarbon gases and vapors, which pass down through the hot coke, and are led away by the exit pipe. The lower part of the retort is full of coke which is being oxidized by the oxygen of the air and steam, the resulting gases pass upward, and are also led away by the exit pipe. As the carbon is burned away in the lower part the whole sinks down, making room for fresh coal to be introduced at the top. This is done either by hand or by a screw feeder. At intervals the bottom door is opened, and a portion of ashes and fine cinder is removed. In practice, we have found it of great advantage to have a proportion of unburnt cinder among the ashes, which serves to keep the mass of ash in the bottom of gas as to render it almost valueless as fuel. The only difficulty in the way of preheating the steam and air is in the construction of a durable form of heater. All who have had experience of steam superheating on a large scale can testify to the troublesome and costly nature of such plant. We are, however, at present working out a form of producer on the preheating principle which we hope will be cheap, durable, and easily worked. I have already spoken of one application of the gas-producing process, the adoption of which will have to depend on the enterprise of individual gas companies. There is another application which we hope will be in operation before long, that is, the erection of plant in colliery districts where dross or slack is plentiful and cheap, where, therefore, it will be possible to work it up for ammonia solely. Even at the present low price of sulphate of ammonium there is a considerable margin of profit on this operation after paying costs of coal, labor, interest, and depreciation.

DISCUSSION.

The chairman said the subject of the production of ammonia from coal and shale was a very interesting one, and there had evidently been a great deal of work done upon it by Mr. Beilby and his friends. The production of ammonia had now become a very large matter, especially since its use in the ammonia-soda process, and also largely for manurial purposes. A few years ago he had statistics which showed that the value of sulphate of ammonia produced from gas liquor amounted to nearly £2,000,000 sterling per annum. He did not know whether those figures were correct, but at any rate it was a very large industry, and there were many points in the paper which it would be interesting to discuss.

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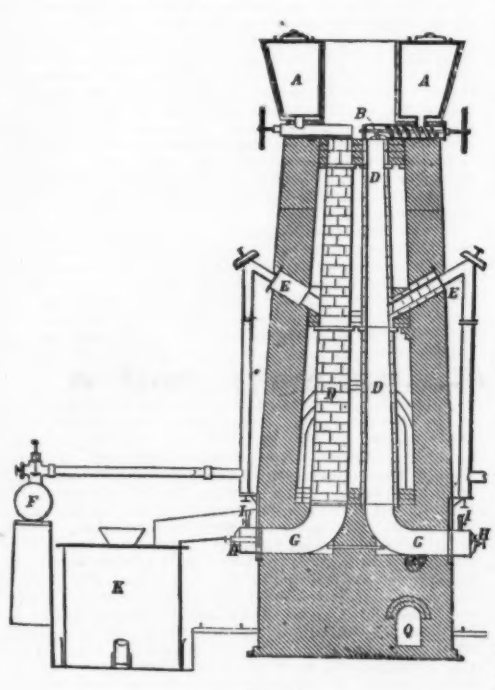

FIG. 6.

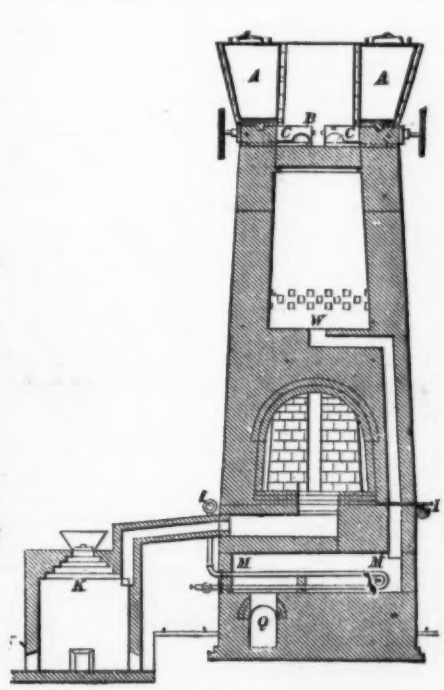

FIG. 7.

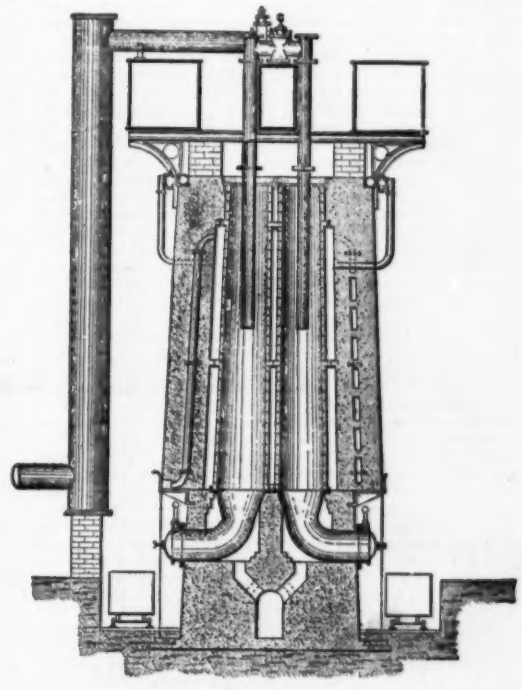

FIG. 8.

RETORTS FOR PRODUCING AMMONIA FROM COAL AND SHALE.

greater should be the prospects of a process which is capable of producing a superior heating gas and an amount of ammonia almost, if not quite, equal in value to the coke consumed.

In two previous papers on this subject (*Mining Institute Scotland Journal*, vol. v., part 5; *Society of Chemical Industry Journal*, vol. iii., p. 216) I have entered at considerable length into the chemical and thermochemical aspects of the process, and in connection with the latter have shown very fully, by means of tables, the theoretical possibilities in the production of fuel gas.

It is not necessary to reproduce these figures in detail; it is sufficient to state the general conclusion, which is, that the free heat energy of the gas from the process, after deducting the heat necessarily absorbed and lost in the process itself, amounts to 70 per cent. of the theoretical heat energy of the original coal. Stating this in another way, we may say that of 100 tons of coal gasified in air and excess of steam, the heat energy of 30 tons will be used in the process, and the energy of 70 tons will be available for outside use in the form of gas. In the calculations referred to, due account was taken of the loss of heat by radiation and conduction from the retort benches. Further, no credit was taken for the recovery of heat from the gases leaving the retort, so that in a certain sense the figures are safe; but in any practical estimate it would be prudent to take the heat energy of the gas as 60 per cent. of the theoretical energy of the coal.

The problem before us, for the last three years, has been to devise a practical apparatus for the manufacure of heating gas by this process. While the theoretical conditions and results could be worked out in the laboratory, the practical solution on a working scale could only be found by the trial and modification of successive plans, at each trial getting rid of some weak point in structure or working. From the necessities of the case, such gradual elaboration of a practical apparatus must be slow, how slow those only know who have attempted to translate a process from a magnitude of grains into one of hundreds of tons. We have not yet attained perfection, and are, perhaps, hardly yet in sight of it, but we can confidently say that the process can be carried out in a practical way with profitable results.

The retort porous and open, so that the steam and air may pass freely through. Care has to be taken that the temperature of the contents of the retort does not rise so high as to fuse the ash and run it into clinkers, as these adhere to the side, and are difficult to remove.

With the object of treating a much larger quantity of coal in each retort, the design shown in Fig. 8 has been adopted. The shell of the retort is built of grooved bricks as before, but it is of circular section, and of much larger diameter than the earlier retorts. The top is closed by a shallow hopper of cast iron, with two small charging doors; through the center of this hopper a large iron pipe is led halfway down the retort. This pipe is for the exit of the gases, and passes up into a large dust-box which runs along the bench. From the dust-box the gas is conveyed by large pipes to the condensers and exhauster. The bottom of the brick retorts rests on an iron snout-piece, which is provided with a door at the outside of the setting. The steam and air are blown in at the front of this snout-piece. The gas and air for heating the setting are led up by pipes between the walls of the building, and are thereby heated before they take fire. The fire gases surrounding the retorts are drawn downward by chimney draught, and before entering the main flues at the bottom of the setting, they give up their heat to the iron snout-pieces, through which the steam and air are entering. The working of these retorts is similar to that already described.

In both the forms of retort described, external heat is applied, and this heat, passing through the walls of the retort, takes the place of the heat absorbed by the reaction within. But it is quite possible to carry out the process of burning coke in excess of steam in a solidly built oven or cupola without any external heating. In that case the heat necessary for the reaction is supplied in one of two ways, either by preheating the steam and air supply, and allowing it to take in the necessary heat, or by consuming a larger proportion of the carbon within the retort by the free oxygen of air—in other words, by using more air with the steam. The latter plan is objectionable, as the quantity of nitrogen introduced with the air so dilutes the resulting gas as to render it almost valueless as fuel. The only difficulty in the way of preheating the steam and air is in the construction of a durable form of heater. All who have had experience of steam superheating on a large scale can testify to the troublesome and costly nature of such plant. We are, however, at present working out a form of producer on the preheating principle which we hope will be cheap, durable, and easily worked. I have already spoken of one application of the gas-producing process, the adoption of which will have to depend on the enterprise of individual gas companies. There is another application which we hope will be in operation before long, that is, the erection of plant in colliery districts where dross or slack is plentiful and cheap, where, therefore, it will be possible to work it up for ammonia solely. Even at the present low price of sulphate of ammonium there is a considerable margin of profit on this operation after paying costs of coal, labor, interest, and depreciation.

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Professor William Foster said he should, perhaps, not read the history of the earlier experiments on this matter in quite the same light as Mr. Beilby, though he quite agreed with him as to the value of some of the experiments. He had no experience himself with reference to the distillation of shale, his own observations having had reference to ordinary bituminous coal and ordinary cannels, some of which came from Scotland, and others from North and South America; and being still engaged in these investigations he was scarcely in a position to discuss some of the interesting points which had been brought forward. The question of the use of steam, and its history, opened up a very wide field, and he did not see how the different results arising from the use of steam at the present time could be explained, without considering more recent researches. Mr. Beilby had already expressed his opinion on some contributions of his (Professor Foster's) to the Institution of Civil Engineers last year; and he thought some of those late experiments threw a considerable light on the theory of the production of ammonia. Prior to these later methods, which were the subject of letters patent, steam was used with the view of preventing the breaking up of ammonia in the retort. Speaking from memory, the amount of ammonia lost in the ordinary distillation of coal was about 25 per cent. from one class of coal, another 35 per cent., another 21 per cent., and another 30 per cent. Those numbers represented the percentages of the nitrogen of coal which by the most advanced process were lost to the gas producer. When steam was introduced into the retort in the way described, it was probable that a portion of this was saved. Of course, after the volatile hydrocarbons had flown, the steam began to act on the nitrogen of the coke. Still, this was a debatable matter, and on it the whole thing turned, for if these recent experiments had any value, it could be shown that this action of steam could only take place by preventing the breaking up of that portion of the ammonia in the retort which came off in ordinary distillation, and was never recoverable as ammonia. There was such a margin of waste in the ordinary mode of distillation, that the steam might very well increase the yield of ammonia without touching the great reserve of nitrogen, which the author and his able colleague, Mr. Young, and others who had been working on similar lines, had been trying to get at. In the latter portion of the paper reference was made to the erection of works for the recovery of by-products from true coal; there were works already in existence not far from Shef-

field for that purpose; but he feared that some of the statements made were scarcely applicable at the present moment. Sulphate was now down in price, say £12 free on board at Hull, whereas a few weeks ago it was up to £15 or £16. He did not know whether it had yet reached its lowest level, but putting the value at £10 a ton, he thought the author allowed very little for the sulphuric acid, labor, and so on, required to work it into sulphate. He feared ammonia had not yet seen its lowest price, and therefore it would be unwise to lay down any hard and fast line as to the money value which this ammonia was likely to bring. The author had done a great deal in showing the practical possibilities of shale distillation, which might be taken as illustrating what might happen in the case of small coal if subjected to similar treatment, but he did not think the operations had been carried on on a sufficiently large scale to influence very considerably the output of ammonium salts.

Mr. Newland said it looked as if there were a great future for this particular mode of treating shale and refuse coal products. Many years ago, in connection with the late Professor Wray, he endeavored to utilize the ammonia from refuse coal; but their experiments were conducted in a more simple manner with the use of hydrated lime, and they did not attempt to prosecute the matter in the way which Mr. Beilby had so ably done.

Professor Forster asked if the author could state the increase in the yield of ammonia by methods similar to the one he had brought forward, and what were the possibilities of increased ammonia production in comparison with what they were a few years ago. In Gartsherrie and other places large quantities of ammonia were being produced at the present time, and it would be interesting to know how much ammonium sulphate was being put on the market from these new sources.

The chairman asked Mr. Beilby whether a much larger amount of volatile hydrocarbons and gas were produced by this process.

Mr. Beilby said he was very well acquainted with and fully appreciated the excellent work which Professor Forster had done in the way of clearing up many of the knotty points in connection with the nitrogen of minerals, and its behavior under dry distillation and otherwise. He had asked further particulars as to what actual results had been obtained from coal. He had devoted the greater part of the paper almost necessarily to the discussion of the subject of shale, because that had been really the principal subject with which he had been engaged, but he did not desire to dwarf in any way the importance of the process as applied to coal. He considered the treatment of coal was far more important, and had far more possibilities in it than shale ever would have. He had given the actual commercial figures of the saving being effected in this one small industry, the Scottish oil trade, showing the saving of ammonia equal to £46,000 sterling per annum. If the whole of the shale were treated in Scotland by this process, it would not much more than double that amount, and it was therefore evident that the possibilities of extension in that direction were very limited, and many years ago, therefore, Mr. Young and himself turned their attention very seriously to the utilization of the nitrogen in coal, feeling quite certain that in it there was a much greater hope of a large success. He had pointed out in the paper a number of practical difficulties encountered in carrying out the processes, but still it had been brought down to this point, that for a year and a half they had been treating coal on a manufacturing scale—a small one certainly, 4 to 5 tons a day—for the production of heating gas and ammonia, and the results had been remarkably steady. It was not a laboratory experiment, and was not under the direction of chemists, but had been conducted by ordinary Irish laborers working retorts, and the results, therefore, were thoroughly practical.

As he had pointed out, the real difficulty was that it took such a long time to burn away the carbon in steam that air had to be introduced to expedite the process. But since that had been done, the whole process had been marvelously simplified, and could be carried on on a large scale. Mr. Forster had almost suggested that it was not possible to obtain the whole of the ammonia present in a material such as coal or shale by simple treatment, with excess of steam of sufficient temperature, but it was possible, as had been proved time after time, to do so. The analytical method at least proved that the whole nitrogen could, by proper care, be obtained, and it had been done time after time in his own laboratory, for, after carefully analyzing the residue and ammoniacal liquors, and striking a balance, it really came out with marvelous accuracy, showing that practically the whole of the nitrogen was accounted for.

In the case of a shale retort simultaneously producing paraffin oil, which necessarily contained about 20 per cent. of the total nitrogen, you could not obtain that portion as ammonia; but in the case of coal, where the hydrocarbon vapors were almost entirely decomposed by steam in their passage through the red-hot coke, the theoretical possible quantity of nitrogen could, with care, be obtained. He had abstained, purposely, from entering fully into the chemistry of the question of the decomposition of steam, and the state in which the nitrogen was found in the coal, because he had already expressed his views in a paper read before the Society of Chemical Industry last spring. Mr. Forster had further asked for information as to the actual quantity of ammonia produced from such sources as blast-furnaces, gas-producers, and, generally, such improved methods as had come into use since 1880 and 1881.

According to a rough estimate recently made, the total output of ammonia from blast-furnaces and coke-ovens in the West of Scotland was from 3,000 to 3,500 tons per annum. He had never heard of any really successful process on a large scale for obtaining it from gas-producers. There had been much experimenting, but he knew no one actually producing sulphate of ammonia by the ton except themselves. The increased quantity of sulphate of ammonia produced in the Scottish oil trade was about 4,000 tons a year, which was a comparatively small quantity as yet; the total quantity produced in the United Kingdom being about 80,000 to 90,000 tons. With reference to the use of lime with coal, they had all been interested in the coal liming process so much advocated lately, but it was quite evident to those who studied the subject that hydrated lime could never take the place of soda lime in producing ammonia in a gas retort. Apart from the state of division in which the two substances existed, the hydrated lime gave off water at much too low temperature to do the work required. The hydrogen ought to be liberated at a temperature at which water decomposed and carbon oxidized.

The chairman had asked as to the loss of hydrocarbons by the excessive quantity of gas, and there he had put his finger on a very important point. In the case of shale distillation, before this new process was introduced, the quantity of gas obtained per ton was something like 1,400 cubic feet. At present, working with steam alone, they obtained 8,000 to 9,000 cubic feet, therefore they found it was necessary to exercise a great deal more care, and to provide a great deal more plant to recover the additional quantity of volatile hydrocarbons thus carried away. In the coal retorts, in which they produced gas to the extent of about 150,000 feet per ton, they had only by scrubbing been able to obtain benzol, or gas naphtha, equal to about half a gallon per ton; whether it was through a deficiency of the scrubbing arrangement, or to a complete decomposition of the benzol in the retorts, he did not know, but it would be quite hopeless to scrub off the volatile hydrocarbons from such an enormous quantity of gas; it cost quite enough to put up the plant which was required for the purpose of condensing the steam out of it.

REPLY TO AN EDITORIAL ARTICLE IN THE "SCIENTIFIC AMERICAN," ENTITLED "PATENT OFFICE EXAMINATIONS OF NOVELTY OF INVENTIONS."

To the Editor of the Scientific American:

It is so serious a charge to bring against a public officer that he disregards the law he is set to execute, that I am reluctant to believe that the author of the leading article in the SCIENTIFIC AMERICAN of March 28, 1885, realized the full force of his language regarding the Examiners of Trade Marks.

He says "one great feature of the work of the Patent Office is that all of its staff are a law unto themselves. Each examiner acts for himself independently upon each application. His action may, and generally does, have reference to the law as laid down by the judges of the higher courts. That such reference may be omitted has very recently been proved in the practice followed in the registration of labels and trade marks. This special departure from the law, as laid down by the Supreme Court of the District of Columbia, has already been fully discussed in these columns."

It will be hard for any disinterested person to interpret this otherwise than as charging that the Examiner of Trade Marks in his recent practice has taken it upon himself to construe the law at variance with the interpretations put upon it by the Supreme Court of the District of Columbia, and to regulate his conduct by such interpretations of his own rather than by those of the high authority referred to. I am not aware of any subject being discussed in your columns to which your remarks can relate, except some articles a few months since regarding the Office construction of the act of 1874 for Registration of Prints and Labels, among which you did me the courtesy to publish a communication from myself. I infer, therefore, that the Examiner's "departure from the law," to which you so pointedly allude, is his refusal to register as prints and labels matter which in his judgment amounts to trade marks. I trust you will do me the justice to lay this statement also before your readers. They are very numerous, and their good opinion is worth preserving; and I should like to have them put in position to decide for themselves whether the charge you make is well founded. The practice of the Office regarding the registration of prints and labels has varied at different times, according as different constructions have prevailed of the act of 1874, which is conspicuously ambiguous. For a long time everything presented was registered without question. Then more rigid practice obtained, and all labels bearing registrable trade marks were refused. This practice continued until the well-known Willcox & Gibbs case in the Supreme Court, D. C., resulting in a mandamus upon the Commissioner to register the label presented. This was soon followed by a similar case of Schumacher & Ettinger, not reported. On the second mandamus, Commissioner Marble instructed the Examiner to be guided in future by these conclusions of the court, and the former practice was accordingly resumed.

So far as the Examiner was concerned, it would have continued to this day. It was not his business, and he certainly had no inclination, to reopen the question. He saw, or thought he saw, in the conflicts of right that were likely to occur, chances for litigation, the result of which, sooner or later, must be a clear exposition of the statute by a competent court, or an opening of the way to intelligent legislation by declaring it void. He was entirely content to let it rest.

It happened, however, that a new Commissioner came into office, and that his attention was attracted to this law and the practice under it. The rest of the story can be best told in his own words, as they may be found in the *Official Gazette* of Jan. 6, 1885, as follows:

"STATEMENT OF THE CASE OF U. S. *ex rel.* ELHANAN L. MOODIE *vs.* BENJAMIN BUTTERWORTH, COMMISSIONER OF PATENTS, DECEMBER 27, 1884.

BUTTERWORTH, *Commissioner.*

Prior to the issuance of the order hereinafter referred to the Examiner of Trade Marks and Labels had been for some time accustomed, under the construction given to the decision of the Supreme Court of the District of Columbia in the case of *The United States ex rel. The Willcox & Gibbs Sewing Machine Company v. E. M. Marble, Commissioner of Patents* (22 O. G., 1366), to register as a label that which was subject matter only for a trade mark, the applicant in each case being permitted to determine for himself whether he would register as a label or trade mark, and deciding absolutely what was and what was not proper subject matter for a label or trade mark. On the attention of the Commissioner being called to this matter, the following order was issued:

'The Examiner of Trade Marks will determine in each case whether that which is presented for registration is in fact a label or trade mark. If it is the latter, it will in no case be registered except upon the payment of the fee fixed by law—to wit, twenty-five dollars.'

The petitioner in this case (Moodie), on April 9, 1884, presented an application covering subject-matter for a trade mark, and requested to have it registered as a label. The Examiner refused, and appeal was taken to the Commissioner, who sustained the decision of the Examiner (see 28 O. G., 1271), the point being that the law devolved upon the Patent Office the duty of determining in each instance whether that which was sought to be registered as a label was in fact a label or only subject-matter for a trade mark. Thereupon applicant filed in the Supreme Court of the District of Columbia a petition for a writ of mandamus to compel the Commissioner to register the subject-matter presented in accordance with the request preferred to the Examiner. The case was fully argued by Messrs. Goepel & Raegener for the petitioner, and Mr. Frank T. Brown, counsel for the Patent Office. On the 22d instant the court in an oral opinion sustained the decision of the Commissioner, and dismissed the bill.

A statement of this case is published for the reason that the opinion seems to obtain that it is entirely within the discretion of the applicant whether he will register that which is subject-matter only for a trade mark as a label; that it is his province unquestioned to determine whether the subject-matter so presented is in fact a label or subject-matter only for a trade mark, and that his determination in that behalf is final. The court has not sustained that view."

I have little to add to this statement. The candid reader will observe that, so far from the Examiner omitting reference to the law as laid down by the Court, he has simply done what the Commissioner ordered him to do. He might have refused obedience, but he was not quite ready to lay his head upon the block. He did as ordered; refused every case of so-called label which in his judgment amounted to a trade mark; expecting, of course, that in some case appeal would be taken. Just as expected, the appeal was taken on behalf of the applicant Moodie, by an intelligent and enterprising firm of solicitors. The Commissioner listened attentively to all arguments presented, kept the case long under advisement, and finally affirmed the Examiner (see his decision *ex parte* Moodie, 28 O. G., 1271). Again, just as expected, and just as desired by the Office, a writ for mandamus was filed in the Supreme Court, D. C., the exact remedy which had proved so effectual in the former cases. The question had never before been argued on the Commissioner's behalf, and both cases went by default; but now his side of the question was fully presented, resulting in the affirmation by the Court of his construction of the law and of the Examiner's action.

It will doubtless occur to the reader that this is a very different state of things from that indicated by the writer of your article, and he will readily exonerate the Examiner from the charge of lawlessness which your language implies. To some readers it may also occur that the discussion of this "special departure from the law," to which you allude, has not been so full as it might have been, since you have omitted to publish the latest conclusions of the Court as set forth by the Commissioner in his statement.

This statement of the Commissioner's was published in the *Official Gazette*, because, the case having been simply a writ for mandamus, it was ended by a refusal of the mandamus. No formal opinion was rendered, though the importance of the case would have made such an opinion of great value. In default of this, the Commissioner's statement was intended to lay before the public the facts for their information. But he could not include all the facts. Without rendering a formal opinion upon the issue, each of the judges took occasion to express orally his opinion of the law; all agreeing that it was incapable of intelligent or consistent construction, and that if, in its looseness and ambiguity, the Commissioner could place any construction upon it, no court ought to interfere with him. I give this substantially as it was reported to me by one who was present. No notes appear to have been taken by anybody. The question is regarded on both sides as finally disposed of, and is hardly likely to come up again.

The efforts of persons interested in the protection of prints and labels will be well exerted in securing the repeal of the law and the enactment of something intelligent in its place. No one can positively tell to-day what sort or degree of protection it was designed to afford. It constitutionality has been repeatedly questioned. Registrations are effected under it, and will continue to be as long as people demand them and pay their fees. The only case adjudicated under it (at least the only reported decision) settled one question—that the use of a label upon the goods, it intended to designate, prior to its deposit in the Patent Office, amounts to a publication, and will vitiate any subsequent registration (Marsh *et al.* v. Warren *et al.*, 14 O.G., 678). This was regarded a matter of such importance that a statement of it is included in the last edition of the "Trade Mark Rules" (Jan. 1, 1885), and probably has led some persons to refrain from filing applications.

I cannot believe you would willingly do me the injustice which your language implies, and therefore hope you will give this letter the same publicity as the article which has called it forth.

Respectfully yours,
F. A. SEELY,
Examiner of Trade Marks.

U. S. Patent Office, March 28, 1885.

[We cannot recognize the body of examiners of the Patent Office as anything but essentially judicial officers, and in that sense as responsible individually for their actions. In the interpretation of the statute that we call for, the Examiner of Trade Marks would lose this character where distinction between trade marks and labels was in question. We have also been at pains to procure the fullest possible statement of the conclusions of the Judges of the Supreme Court of the District, which we publish in the SCIENTIFIC AMERICAN of this week, thus going far beyond the Patent Office in our efforts to set the question at rest. We acknowledge that we prefer such a record to the "latest conclusions of the court as set forth by the Commissioner in his statement." Our correspondent's statement of what the Judges said is hearsay evidence, and can count for but little. Yet even from this it would appear that the court simply refused to act. The inaction of the court, for such it was, has little force, and applies

only to the single case under consideration. We feel that any apprehensions of unjust treatment by us of the Trade Mark Examiner will be done away with by our publication of his letter. He, too, will have to acquit us of any desire to cloud the discussion of the subject by not publishing from the *Official Gazette* the statement of the decision in the Moodie case. Having succeeded in getting more satisfactory opinions of the different Judges, we take great pleasure in publishing them as our contribution to the case.—EDS. SCI. AM.]

SALICYLIC PAPER.

THIS extremely useful paper, according to the *British and Colonial Druggist*, may be thus prepared:

Any white absorbent paper is suitable for this purpose, but the particular kind to be used must depend somewhat on the special object for which it is intended. Thus, for covering honey, preserves, milk, cream, or similar articles ordinary English white filter—or blotting—paper answers well; but for butter, fresh meat in small pieces, or delicate fruit and vegetables, a less "tender" paper should be selected; while, if required for wrapping up large joints of meat, and the coarser fruits, etc., a still more substantial material must be chosen, such for instance as a stout, unpressed "printing" or soft white "sugar paper." It is almost essential that the paper employed should be unglazed or practically without sizing of any kind.

Any convenient quantity of salicylic acid (Von Heyden's No. 1) is taken and divided into two equal parts; one of these is then dissolved in the following solution, previously warmed: Sulphate of sodium, 30 grains; biborate of sodium (borax), 50 grains; water, 1 fluid ounce.

The solution should be poured hot upon the acid, with constant stirring, not much more of the liquid being used than is needed to effect a complete solution.

The other half of the acid is meanwhile to be digested in a little warm glycerine diluted to the density of about 1·100 or 1·150, one-third more glycerine than has been found requisite to effect the solution of the acid being subsequently added. Both solutions may then be mixed together, water being cautiously added, until the strength is equal to from 3 per cent of salicylic acid for the thicker to 5 per cent for the thinner papers. Should any crystallization or precipitation of the acid occur, glycerine must be added by degrees until it is again taken up and the liquid becomes perfectly clear.

The papers to be impregnated should be immersed one by one in a large shallow dish or pan, about two-thirds filled with the solution, somewhat in the same way that paper is "salted" for photographic purposes. If the solution be used rather warm, say about 140° or 150° Fah., four or five minutes' soaking will be sufficient; but for the thickest and least pervious paper a somewhat longer period is advisable. If the liquid be used cold, fifteen or twenty minutes is not too much time to allow for maceration before taking out the sheets, draining them, and hanging them up to dry, which latter operation is preferably completed in the sunshine, before a fire, or in a cool oven.

These salicylic papers may be kept in a cool dry place, pressed flat between the leaves of a book or portfolio, or rolled up tightly for any length of time, without deterioration or loss of preservative strength.

A large number of articles of food and drink and of animal and vegetable substances, ordinarily liable to fermentative or putrefactive change, may be prevented from decomposing for some time by the judicious use of salicylic paper; which we have known to keep free from "mould" for several months some badly prepared ext. taraxacum, which without it invariably showed symptoms of the development of *Penicillium* within a few days.

NOTES ON SOME JAPANESE OILS.*

By E. M. HOLMES, F.L.S., Curator of the Museum of the Pharmaceutical Society.

AT the close of the International Health Exhibition at South Kensington, some specimens of the fixed oils used in Japan were presented by the Japanese Commissioner to this Society. These seemed to be of sufficient interest to demand a short notice in the columns of our journal. This I had intended to have given later on, but my attention having been called by Mr. R. H. Davies to some oils imported from China, very similar in character to some of these Japanese oils, the present moment seemed to be the fitting one to notice such of the latter as appeared to resemble the Chinese oils, reserving a notice of the remainder to a future date.

Brassica Oil.—Two qualities of this oil were exhibited at the International Health Exhibition, one of a yellow color and of "superior quality" and closely resembling European colza oil in appearance and odor, and without any pungent taste; the other similar in color to linseed oil. The former is probably obtained from the seeds of the *Aburana* of the Japanese (*Brassica campestris*, L.), of which three varieties—early, common, and late—appear to be cultivated to a considerable extent in Japan. The oil is used for culinary and lighting purposes. According to Dr. E. Mene, it is also used in tobacco manufacture to prevent the leaves falling to powder after rapid drying. Lampblack for use in making Chinese ink is also made by burning the oil under conical receptacles pierced with holes in the upper part. The residue after the expression of the oil is used for manuring plantations of *Camellia japonica* and other plants.

The dark colored oil is probably obtained from the seeds of the *Petsai* (*Brassica sinensis*), and is used for similar purposes. It is also employed in medicine as a purgative, and as an external application in certain diseases of the skin. *Brassica sinensis* is also grown in immense quantities in China, especially in the Yangtsekiang and Hankiang valleys, in the province of Hupeh, and to some extent also in the provinces of Kiangtsu and Chikyang. The seed is ripe in May. It is probably this kind of oil that has recently been sent to the London market, and which Mr. Davies has now examined and reported upon.

Camellia Oil.—The specimen exhibited at the International Health Exhibition was labeled oil of *Camellia Japonica*. It is of the color and consistence of olive oil, and in consequence of its containing very little solid fat, and not yielding a deposit when exposed to considerable cold, it is employed by watchmakers in Japan, according to Mr. Murai. In Siebold and Zuccarini's Flora Japonica (p. 157) it is stated that the oil obtained from the seed is mixed with Japanese wax (*Rhus succedaneum*) and perfumed with oil of cloves and other essential oils to form a pomade which is in common use in Japan. A similar oil is obtained in China from *C. oleifera*, according to Mr. C. Ford,* who observed the shrub in cultivation in the neighborhood of the West River.

In that district it is used to supply the growers with oil for culinary purposes and for anointing their heads, but is not grown in sufficient quantities for export. It must, however, be largely cultivated in other parts of China, since I find, from a statement in Spons' Encyclopædia (p. 411), it forms an important article of trade, having been exported from Hankow to the extent of 3,640½ piculs (of 133⅓ lb.) in 1878, and 5,826 piculs in 1879; Shanghai also imported 5,792¼ piculs in 1879, and exported 2,991¼. The oil is obtained by crushing the seed to a coarse powder, boiling, and then pressing. The seeds of *Camellia japonica* are ripe in September. It may be mentioned here that the seeds of *Thea sinensis* (*Camellia thea*) were recently offered in the London market under the name of "tanne" seeds ("tanne" meaning seeds according to Mr. Murai). The seeds are capable of yielding one-third of their weight of oil,† and according to a recent examination by Peckolt yield also 13·8 per cent. of starch and 1 per cent. of theine.‡

The camellia oil is non-drying, very fluid, of pale color, and free from unpleasant odor, and doubtless if prepared by cold pressure would compare very favorably with the best olive oil, and judging from the price in China (about 4*d.* to 6*d.* per lb.) could certainly compete with almond oil for many uses in this country, if not with olive oil.

Wood Oil.—The Japanese oil exhibited under this name is stated on the label to be the product of *Elæococca cordata*.§ It must not be confounded with the oleoresin known as wood oil or gurjun balsam, obtained in India and Malaya from *Dipterocarpus turbinatus* and other species. The Japanese wood oil is a fatty oil, obtained from a euphorbiaceous tree called "abura giri" *i. e.*, oil tree, and "yani kiri," *i. e.*, mountain or wild kiri—"kiri" being the Japanese name for *Paulownia imperialis*, whose leaves are very similar in appearance. The tree grows wild in the warmer parts of Japan, and is also cultivated in mountainous places and woods, as well as by road-sides, chiefly in the provinces of Homodaki and Figo, in the central parts of the isle of Nippon, and in the provinces of Suruja, Sagami, Musasi, and Idzu.

The seeds yield 35 per cent. of oil by cold expression, but the specimen presented to the Museum of the Society has probably been made by boiling the crushed kernels previous to expression, since the cold-drawn oil is colorless, inodorous, and nearly tasteless, and according to Cloez ‖ has a sp. gr. of 0·9362; moreover, it solidifies rapidly when exposed to light in a closed vessel filled so as to exclude air. The Japanese oil, on the contrary, has a brownish color and a higher specific gravity, as has been shown by Mr. Davies; it remains perfectly fluid when exposed to light. The wood oil, or "doucouá," as it is called in Japan, is employed to fill the pores of wood before applying lacquer; it is also used, like tar, to render wood impermeable to moisture. It is stated by Cloez to be the most drying oil known. In medicine the oil is used in skin diseases, and mixed with other ingredients to make an application for ulcerated wounds and carbuncle. The cold-drawn, pale-colored oil is, according to Dr. E. Mene, used for varnishing furniture, umbrellas, paper, and paper leather.

In China the oil is one of the principal articles of native manufacture; in the provinces of Kyangsi, Chikyang, and Szechuen it is universally employed for painting and calking junks and varnishing and preserving all kinds of woodwork. Hankow is the chief market for the outward trade, and exported in 1878 as much as 336,053 piculs (133⅓ lb.), and 203,820¾ piculs in 1879. The importance of this commercial product has already attracted the attention of the Director of Kew Gardens, for it is stated in the Kew Report for 1880, p. 11, that seeds of the tree had been obtained from Szechuen and distributed to Ceylon, Demerara, Dominica, Jamaica, Zanzibar, and the United States. An attempt to naturalize the tree in Algeria has also been made by the French.

In view of the frequent adulteration of linseed oil with resin oil, etc., the appearance in the market of an oil possessing still greater drying properties may be hailed as a circumstance likely to lead to the production of a purer and equally valuable drying oil by our colonial possessions.

* Read at the Evening Meeting of the Pharmaceutical Society of Great Britain, February 4, 1885.

* *Jour. Soc. Arts*, 1883, p. 513.

† Spons' Encyclopædia, p. 1411.

‡ *Pharm. Jour.*, [3], xv., 508.

§ I am reminded by Mr. W. T. T. Dyer that the genus *Elæococca* has been sunk by Bentham in *Aleurites*. The name should therefore be *Aleurites cordata*.

‖ *Comptes Rendus*, vol. lxxxi., 1875, p. 409.

THE ACTION OF LIGHT ON SILVER CHLORIDE.

By SPENCER B. NEWBURY.

THE blackening of silver chloride when exposed to light has been explained in various ways, but the conclusions of even the most careful observers show no agreement, and but little accurate experimental work seems to have been done to clear up the problem. Von Bibra (Journ. f. Prac. Chem., 1875, p. 39) has carefully collected the results of all important observations in this field, and in the same paper gives an outline of his own work on silver chloride and the *subchloride* produced by heating silver citrate in a current of hydrogen and treating the product with hydrochloric acid. The authorities quoted in this paper agree upon the following facts:

1. In the darkening of moist silver chloride by the action of light, chlorine is liberated, apparent by its odor, and easily recognizable by the usual tests.

2. The darkening effect is retarded by the presence of free chlorine, ferric and cupric chlorides, and nitric acid, and accelerated by stannous chloride.

3. Blackened silver chloride is not decomposed by nitric acid; when treated with ammonic hydrate, silver chloride is dissolved, and a residue of metallic silver is left.

In addition, Von Bibra's investigations led him to the following conclusions:

1. Dry silver chloride, exposed to light, with frequent stirring until completely blackened, shows no perceptible loss of weight. The blackened chloride is not decomposed by nitric acid.

2. Silver citrate heated to 100° in a current of dry hydrogen until constant weight is obtained yields a black powder which is soluble in a very large quantity of cold water, giving a red solution, and which, on treatment with hydrochloric acid, yields pure silver subchloride, the formula of which is Ag_4Cl_3. This compound is decomposed by nitric acid, leaving silver chloride; also by ammonia, leaving metallic silver. Von Bibra concludes that since chloride of silver, blackened by light, is not affected by nitric acid, it cannot be silver subchloride.

As there are on record no accurate observations of a loss of weight on exposing silver chloride to light, I first made this point the subject of a series of experiments. The calculated quantity of silver nitrate necessary to yield 0·1000 gramme of chloride was accurately weighed out, dissolved in 100 c. c. of water contained in a flask, and precipitated by the addition of a very minute excess of sodium chloride dissolved in the same quantity of water. The finely divided precipitate remained suspended in the water for a considerable time, subsiding after several hours' exposure to light. The exposed substance was in every case brought upon a weighed Gooch filter (consisting of a platinum crucible, the bottom of which is perforated and covered with a thin layer of asbestos), dried at about 140°, and weighed. By the use of this admirable contrivance it was found possible to reduce to a minimum the experimental errors which have hitherto made observations on this point unsatisfactory.

To ascertain the amount of possible loss, the precipitate produced in the flask was several times directly weighed without exposure to light, with the following results:

	Found.	Calculated.
1.	0·0996	0·1000
2.	0·0997	"
3.	0·0997	"

A number of flasks were prepared as described, and exposed for varying periods to direct sunlight; meanwhile a current of air was continuously drawn through the liquid to retard subsidence and carry off liberated chlorine. After the exposure the precipitate was brought on to the filter, dried at 140°, and weighed; then treated on the filter with hot ammonia solution, and finally the filter with the residue of metallic silver dried and weighed again. In every case a distinct loss of weight was observed, and the residue of metallic silver after treatment with ammonia generally corresponded approximately to the loss of chlorine.

Since the precipitate of silver chloride soon collects at the bottom of the flask as a black, curdy mass, it is evident that but little additional effect will be produced by light after the subsidence is complete.

Four similar flasks, as described above, exposed side by side to direct sunlight for several days, gave the following results:

	Weight.	Loss.	Metallic silver.	Met. silver calculated from loss.
1.	0·0967	0·0029	0·0054	0·0085
2.	0·0979	0·0018	0·0076	0·0054
3.	0·0969	0·0027	0·0078	0·0081
4.	0·0982	0·0015	0·0062	0·0045

I am not prepared to offer any explanation of the discrepancies between the amounts of metallic silver found and those calculated from the loss of chlorine. In a very large number of experiments the same lack of agreement showed itself. The figures given serve, however, to prove that there is a distinct and weighable loss of chlorine on exposing silver chloride to light.

Similar experiments were made with the addition of small quantities of stannous chloride. In this case the precipitate is quickly blackened on exposure, soon assuming a gray color, and does not completely subside even after standing some days. On examination the precipitate was found to consist almost wholly of finely divided metallic silver.

In order to ascertain, if possible, whether a *subchloride* results from the action of light on silver chloride, or whether metallic silver only is formed, 10 grammes of silver chloride were exposed to the sun, under water, for several days. During the exposure the substance was frequently stirred to present fresh surfaces to the light, and a current of air was constantly drawn through the liquid, as in former experiments. A small quantity of the resulting dark purple substance, dissolved in ammonic hydrate, left a residue of silver equal to 2·94 per cent. of the amount treated, which gives by calculation a loss of chlorine of 0·96 per cent. I now hoped to isolate the product of reduction by dissolving out the undecomposed chloride, exactly as in the *fixing* of a photograph. The reagents employed for this purpose were sodium thiosulphate, potassium cyanide, and sodium chloride. In each case, *metallic silver only* resulted. Even a cold concentrated solution of sodium chloride, frequently renewed, dissolves finally the last trace of silver chloride, and leaves a residue of gray, finely divided metallic silver. The purity of this residue was proved by a number of careful quantitative determinations.

These results certainly lead to the conclusion that in the blackening of silver chloride by light, metallic silver is formed, and not a subchloride. Otherwise we must assume that the subchloride is decomposed into silver and silver chloride by the action of a cold solution of sodium chloride; which is at least highly improbable. The same conclusion has been reached by other investigators, but the experimental proof given by the action of solvents has been, so far as I know, heretofore lacking. Mr. P. C. Duchochois, whose work is reported in Anthony's Photographic Bulletin for June and November, 1884, concluded that no subchloride is formed, from the fact that after dissolving blackened silver chloride in ammonia, no ammonium chloride is to be found in the solution; supposing the reaction to be as follows:

$$3Ag_2Cl + 4NH_3 = 3Ag_2 + 3NH_4Cl + N.$$

There can, however, be no objection to writing the reaction thus:

$$Ag_2Cl = AgCl + Ag —;$$

in which case the ammonium hydrate simply plays the part of a solvent of silver chloride; hence it does not seem to me that the action of ammonia throws any light on the constitution of the substance.

The only remaining evidence of the existence of silver subchloride is the fact that the blackened compound is not dissolved by nitric acid. This fact Von Bibra cites as evidence that the substance is *not* subchloride, since his subchloride prepared from reduced silver citrate *is* decomposed by nitric acid. It has been suggested that the silver may be present in a passive form, but it seems to me more probable that the action of the acid is merely retarded by the presence of a large amount of insoluble chloride. Moreover, I find that long boiling with dilute acid does dissolve some of the silver. A sample of blackened silver chloride which gave on treatment with ammonia 2·94 per cent. silver showed, after boiling three times with fresh additions of dilute nitric acid, 2·74 per cent., 2·36 per cent., and 1·98 per cent. respectively.

I have made many experiments with a view to prepare silver subchloride from the citrate exactly as Von Bibra describes; but although great precautions were taken to thoroughly dry and purify the hydrogen and the silver citrate used, I have never succeeded in obtaining a constant weight. In every case, however, the chloride prepared by acting on the reduced citrate with hydrochloric acid yielded only metallic silver on treatment with sodium chloride solution. Although I do not regard these last experiments as conclusive, and am at present engaged in repeating and extending them, they are sufficient to strengthen the doubt which many chemists have expressed as to the existence of the subsalts of silver.

Laboratory of Cornell University, Jan. 10, 1885.

—*Amer. Chem. Journal.*

WINTER SCENES ON THE BROCKEN.

The Brocken, in the Hartz, which is the highest mountain on the North German plain, is exposed to winds from all directions, especially to the highly saturated north winds. In winter the top of the Brocken, 3,746 ft. above the level of the sea, is entirely surrounded by clouds, and whenever the temperature descends only slightly below the freezing point, the particles of water composing the clouds are converted into ice as soon as they come in contact with a solid object. One layer of ice is formed on another, and the trees, telegraph poles, etc., on the mountain soon acquire the most grotesque shapes. In the months of January and February of this year, not a single sunbeam could act on the ice on the Brocken for about six weeks, and the hoar-frost produced most wonderful effects.

The middle picture in the lower row of the annexed cuts shows a telegraph pole surrounded by ice and having a form resembling a mushroom. The ice at the bottom of the pole is 4 ft. in diameter, and at the top 9 ft. As the wind blew from all directions, the layer of ice is of equal thickness on all sides of the pole. The wires have to be removed at the beginning of winter, as the ice accumulating on them breaks them. Three years ago a wire suspended from two poles supported a load of ice weighing about 1,100 lb.

The numerous pines on the Brocken are also covered with ice, and assume the most grotesque shapes, some resembling nuns, others polar bears, rams, etc., as is shown in the middle picture of the top row, and the end pictures of the bottom row of the annexed cuts. Occassionally the sun breaks through the clouds, which are in continual commotion, and then it seems as though an enormous ocean surrounded the mountain. The effect produced is beautiful. In the end cuts of the upper row the cloud forms are shown.

The annexed cuts were made from photographs taken by Dr. Assmann.—*Illustrirte Zeitung.*

BIRD CHARMERS.

The sparrows of the Tuileries are in mourning. He who was accustomed to charm them, having contracted inflammation of the lungs through the Siberian cold, while in the exercise of his good mission, is dead.

"Gentle monomaniac, he came every day at the opening of the gates, with a jolly countenance, and his hands in his pockets, to scatter crumbs of bread for his dear pupils. And how they loved him, and how they flew with merry chirps toward the bench on which he sat! In an instant, quickly familiarized, they perched upon his shoulders, squatted upon his knees, ran along his arms, and even climbed upon his head, like the pigeons of St. Mark, jealous of the favorite that had just taken with its bill the crumb held between his lips. This partook of magic, and it was interesting to behold the astonishment of the street boys as they watched this old man with youthful ways covered with more birds than were in all the trees of the park.

"Mr. Bour, for that was the name of the charmer, had a physiognomy that was wholly Parisian. All Paris knew this good man with rosy cheeks, and small twinkling eyes, and amiable and sympathetic nature, whom premature baldness would have rendered grave had not a thin black mustache (perhaps dyed) given him a gay and free and easy look."

It was in these words that a large daily journal announced Mr. Bour's death.

But Mr. Bour did not invent this specialty. We remember having in childhood admired another bird charmer behind whom an immense crowd used to gather in the Tuileries in order to watch flocks of pigeons and sparrows, obedient to his least signs, whirl around him with merry chirps. This charmer was named Edward du Peyron, and Mr. Fournel asserts that he was an old sub-prefect who had been dismissed by Mr. Guizot. He left a son, who long continued his practices in Diane Alley.

Always with the same hat and clothing, there was nothing to distinguish this charmer from the host of promenaders; but the ring-doves and sparrows were never deceived. As soon as he made his appearance in the distance, the former left the branches of the tall chestnut trees and flew from the center of the grass plats, and the latter came out in swarms from the smallest shrubs, and all followed him until he came to a standstill. The boldest at once alighted upon his

BIRD CHARMER.

CLOUDS.

GROUP OF PINES.

CLOUDS.

GROUP OF PINES.

TELEGRAPH POLE.

GROUP OF PINES.

WINTER SCENES IN THE BROCKEN.

shoulders, upon one of his outstretched arms, or one of his fingers, and took from his hand or lips the food that he offered them, while the others, arranged in a line upon the iron railings, or hopping about on the ground, or sustaining themselves in the air by rapid flaps of their wings, impatiently awaited their turn.

The crowd, forming a circle around the charmer, took extreme delight in this charming spectacle. As every passion has its bad side, our charmer was jealous of his prerogative and desired to exercise it alone. When, excited by his example, some ill-advised spectator left the circle and tried by the adroitest means to get the best made pellets of bread—the most appetizing dainties—in order to attract some of the birds to him, the charmer knit his eyebrows, measured the rash fellow from head to foot, and gave him a withering look. If the attempt miscarried through the immediate flight of the delinquent, joy beamed from his countenance; but if not, he took leave of the birds with a gesture, and walked away with a majestic but sad air. His day of pleasure had been spoiled, and it was necessary to wait for the next day.

Mr. Bour and Mr. du Peyron carried nothing in their hands or pockets, but Mr. Picard, on the contrary, had a means of persuasion. At the Press fete in the Bois de Boulogne, June, 1884, Mr. Picard asserted that he could exert his influence over the first birds that were presented to him, and that it would take but a quarter of an hour to persuade them to select a domicile on any tree whatever, on condition, however, that he had prepared the latter. In fact, birds charmed by him were observed to remain for two days upon two little firs, without leaving them.

This assertion gave rise to a challenge from a Mr. Loizey. This gentleman, having procured a dozen birds, took them himself to the Champ de Mars, and lent them to the charmer for a quarter of an hour. At the end of this time, Mr. Picard was to open the cage and let the birds out, and they were to fly to a shrub brought by him and placed at about a hundred yards from the cage. By the terms of the wager, $10 were to be paid by Picard to Loizey for every bird that did not reach the goal. The cage having been opened at two o'clock, if the birds did not reach the shrub by quarter past two, it was to be considered as a loss. Per contra, Mr. Loizey agreed to pay the same sum for every bird that flew in the direction of the shrub.

The announcement of this open air exhibition drew a pretty large crowd—too large, in fact, for, despite the entreaties of the two who were interested, the curious crowded around the cage and shrub in such numbers as to occupy nearly all the space necessary for the carrying out of the experiment. About forty yards were all that could be obtained from the idlers. The birds, set free at this distance, gradually settled in the shrub, the leaves of which had been impregnated with a colorless and mysterious liquid—Mr. Picard's charm.—*Science et Nature.*

THE EARTHQUAKES IN ANDALUSIA.

THE earthquake shocks in Spain, which began to make their action felt Dec. 24, 1884, and which destroyed cities, caused the death of thousands of inhabitants, shook the mountains, and made wide fissures in the earth, had not yet ceased to strike terror into the different parts of Andalusia on the 24th of January, the date at which Mr. Nogues addressed an interesting letter to us upon the subject.

After a few days of rest on the part of the subterranean forces, it was supposed that the earthquake was over. But such was not to be, for recent data teach us that on the 27th of February new shocks were felt at Granada, Malaga, and Loja. Several edifices that had remained standing were overturned, but fortunately no one was hurt. According to a telegram from another part of Madrid, under date of March 7, three other shocks made their action felt at Alhama.

When will such disastrous occurrences cease? Unfortunately, it is impossible to say, and if we take examples from the past, it is to be feared that movements of the earth in Andalusia will manifest themselves for some time yet. The terrible earthquake that occurred in Calabria, Italy, in 1783, and which is one of those that have been best studied in modern times, was prolonged for four consecutive years, the shocks having begun in 1783 and not having ceased till the end of 1786. This earthquake, which caused great ravages in Sicily and Italy, opened deep fissures in the earth analogous to those that were formed in Andalusia. It has appeared to us to be of interest to compare these two phenomena, which were nearly alike in their effects, in order to show that nature is accustomed to proceed through the same laws and causes in her manifestations.

At the time of the recent earthquake in Andalusia, great crevices opened in the environs of Periana, and suddenly swallowed up several houses. The great Guevejar crevice, shown in Fig. 1, is the largest of those that were formed during the last catastrophe in Spain. It is nearly two miles in length, but its depth, which is great, has not been determined at all points. The fissure is divided into several ramifications, and traverses Guevejar. A few houses that stood on the spot where the earth opened were suddenly swallowed up. One church disappeared in the yawning chasm, and at present nothing can be seen of it but the top of its steeple, which projects slightly above the surface of the ground. The village of Guevejar is situated six miles from Granada, at the foot of Mt. Cogollos. All the upper part of the latter was fissured, and is now divided by a crevice more than half a mile long and four yards deep. This crevice forms part of the main fissure.

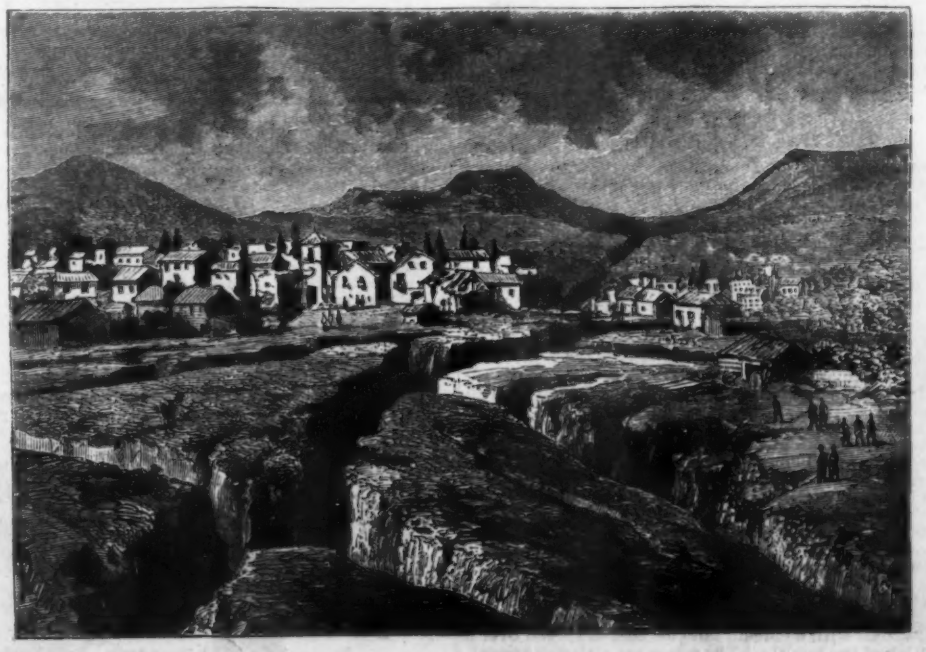


FIG. 1.—THE GREAT FISSURE AT GUEVEJAR, ANDALUSIA.

One of our correspondents, Mr. C. Haurie, of Jerez de la Frontera, has communicated to us some interesting details in regard to the formation of these great fissures at Periana and Guevejar. They opened, it seems, with formidable noises, comparable to those of a cannonade. The inhabitants were so surprised at the rapidity with which these were produced, that some of them hardly escaped the danger of being swallowed up. A muleteer came near disappearing in the fissure at Guevejar. One of his mules, in fact, did fall in.

As above stated, similar movements of the earth occurred a little more than a century ago in Italy, at the time of the earthquake in Calabria. One of the fissures that formed at Polistina is shown in Fig. 2. This was remarkable for its depth. In the city of Terranova a few houses suddenly disappeared, and a large, solid masonry tower was split in a vertical direction, one of its sides being elevated, and the foundations being raised above the earth.

The Royal Academy of Naples published a very complete description of this earthquake from data gathered by its members, who visited the various localities. This report also speaks of the fissures at Jerocarne, which extended in all directions and radiated from one center in common. Near Oppido the earth opened and then immediately closed, after swallowing up several houses. In the vicinity of Cannamarie, four farmhouses, some workshops, and large residences were so completely buried at the bottom of a fissure that not a vestige of them could be seen.

During the earthquake in Calabria, as during that in Andalusia, the thermal waters increased perceptibly in volume and temperature. The earthquake of 1783 was much more destructive than that of 1884. The number of persons who perished in Sicily and the two Calabrias has been estimated at forty thousand. A large number of victims was buried under the ruins of the houses, and many peasants, on taking refuge in the fields, were swallowed up in the fissures just described, and which surely constituted one of the most terrible effects of these great cataclysms of nature.

Then, as to-day, the aspect of the ruined places was pitiful. When the naturalist Dolomieu visited Polistina after the catastrophe, he could not avoid a feeling of terror mingled with compassion. "Nothing escaped," says this learned explorer, "not a single house, not a remnant of a wall remained standing. On every side were to be seen piles of stone, the sight of which would not have made it supposed that at the place they occupied a city had ever existed. The fetid odor of corpses arose from amid the ruins."

Happy the country that is not exposed to such catastrophes!—*La Nature.*

MEXICAN ARCHÆOLOGY.

DR. BRINTON lately read an interesting paper before the Philadelphia Academy of Natural Sciences.

When the Spaniards first landed in 1518, they found a variety of tribes in Mexico speaking by no means one language, but diverse, and entirely independent in

FIG. 2.—THE GREAT FISSURE AT POLISTINA, CALABRIA.

their governments. Thus, six or eight wholly different nations as to speech were about on the same level of culture. The territory of the Aztecs, or Nahuas, extended from the Gulf of Mexico to the Pacific Ocean, from Sonora, on the northern part of the Gulf of California, to Guatemala along the Pacific. The main seat was in the valley of Mexico, but the people were not under one government; the separate government, under distinct leaders, were frequently united under one confederacy. The Tarascos, occupying what is now the State of Michoacan, were a highly developed and cultivated race, speaking a language that resembles the Greek in many of its forms. Between the Aztecs and the people of Central America, the Tapotecs, occupying the country about the Isthmus of Tehuantepec, were of considerable importance, and had reached a high degree of culture.

The Mayas of Yucatan held a territory extending from the present peninsula of that name almost to the Pacific. One branch of the nation is found quite north in Mexico, around what is now Tampico, extending almost to the mouth of the Rio Grande, and its location is important as connected with civilization in that part of the continent. The legends point conclusively to the north for the original seat of culture and life. Maya tradition goes back very nearly to a time contemporary with the beginning of the Christian era. The Huastecos were a branch at Tamaulipas (from the Rio Grande to the Panuco), where remarkable ruins recently discovered show a region that had been densely settled by a people skilled in pottery and in the working of stone. Legends collected immediately after the Spanish discovery relate that their arts and civilization came from the northeast. Linguistically, the people derive from the northwest coast. The language is still spoken in Sonora, and even farther north, among the Shoshones; the language spoken by the Utes, root-diggers, is one in origin with the Aztec. They seem to have derived their civilization from somewhere in the area of Texas or the Mississippi valley.

In 1325 the foundations were laid of the city of Mexico; the city of Tenochtitlan was built upon the islands in the lake of Mexico. The legends go far beyond the horizon of that date, which may be taken as historical. The story of the Toltecs, of Quetzalcoatl, the culture hero, the father of religion and of the arts, who is also the demiurgic creative deity, Dr. Brinton regards as purely mythical, nor did the alleged ruler exist except in the imaginations of his people. Here the very recent publication of M. Desire Charnay was referred to, and laid upon the table. M. Charnay is an enthusiastic explorer, whose enterprise has been carried out by the pecuniary aid of Mr. Lorillard, the New York tobacco merchant. Charnay's report has just been published in Paris; and this was an early copy received in Philadelphia.

MEXICO IN THE BRONZE AGE.

The Indians of the United States belong in the stone age; those of Mexico and Central America, in what is called the age of bronze. They were well acquainted with its manufacture. They used about 90 per cent. of copper and 10 of tin. It was made into utensils, ornaments, and weapons, very frequently into bells. Mexico was a country of bells; they had no clappers, but were made something after the pattern of sleigh-bells; they were employed both as ornaments and for religious ceremonies. The bronze knives were semi-lunar in shape, similar to knives of flint. The spear and lance heads and agricultural implements were of bronze. The tin came from mines fifteen to twenty miles southwest of the city of Mexico. Gold and silver were considerable manufactures. Cortez, and Peter Martyr bears him out, said they were better workmen than could be found in Europe. Goldsmiths' specimens taken to Madrid showed they could stand the comparison well. The objection has been urged that these Indians showed no such skill after the Conquest. By a law passed in Mexico a few years after the Conquest,

the natives were forbidden to work in metals, lest they should conceal some of the treasures, therefore the skill soon died out. They knew the uses of quicksilver as an amalgam for the precious metals and how to eliminate it by subjecting them to gentle heat. They excavated for quicksilver in the mines of Almaden; it is even asserted that the use of amalgam was brought to Europe from Mexico. They did not know the use of solder. Their mines were not mere excavations or holes, but had galleries and shafts, with appliances for extracting pieces of ore.

SPECIMENS OF POTTERY, STATUES, JADE, ETC.

They were skilled in the manufacture of stone for weapons, and their utensils of domestic use showed skill and variety. They worked in obsidian, a volcanic glass, dark in color, with a sharp cutting edge. They used this for razors, for shaving the face or head. A skillful workman was able to split off these razors by the thousands in an hour, and though so brittle that it was difficult to work up except by splitting from a central nucleus, the ornaments known as lip-stones, small cylinders flared at either end, were as common in use as earrings. (These were shown in perfect preservation.) They had a large variety of stones used in sculpture and for mosaics. The most esteemed was jade, not the precious jade of China, but a fine variety found in Mexico, of which they made masks, amulets, figures of animals, planets, and small gods. Specimens of these were shown. Some of their mosaics were extraordinarily beautiful, in geometrical figures, the combination of colors showing the same skill as that of Italian artists. These are found in mounds and sepulchers. They were skillful wood-carvers, working with both stone and bronze knives. Most of these specimens have perished. Their drums were of wood, elaborately carved; also the handles of weapons were elaborately carved and chiseled.

Featherwork, both for garments and pictures, using the most brilliant hues of tropical birds, was continued as a hereditary employment. They could copy any painting brought from old Spain quite as brilliantly in feathers as in oils. In pottery their skill was nearer perfection than that of northern tribes. They made small figures and comparatively large statues of pottery. Masks of pottery, of laughing faces, were shown; excepting in one feature, these were quite Greek in finish, but the nose and facial line was a sharp and humorous exaggeration. They employed different colored pates on the same vase, but they did not understand the art of representing the figure with much accuracy. The figurines found in tombs and fields are reminders of Egyptian figures, both in head-dress and in the pose of the arms. This decoration of the head was really in imitation of the stiffly quilled ruffles made of paper (of the maguay plant) worn for head-dresses. Their art of painting in the MSS. still extant was not painting in an artistic sense, not for beauty, but for use and record, and this business employment of it probably destroyed the capacity for painting as a fine art.

The distinctive fine art they cultivated was music. They had the flute and the drum. The flute was of pottery (a specimen shown) of hollow reeds, of wood and bone. Mr. Cresson has examined the scales and musical relations of the flutes of the Poinsett collection in the Academy (loaned to it for exhibition by the American Philosophical Society, and pronounces them well adapted for musical purposes. The sound of their drum was lugubrious and sad, not cheerful or enlivening, but popular to this day in Mexico and Central America.

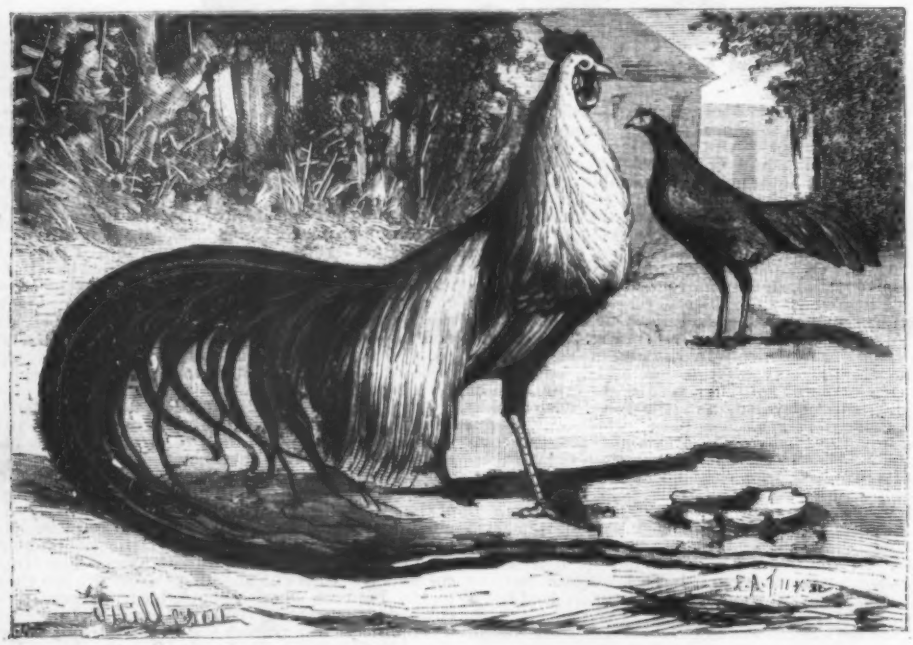
CHARACTERISTICS OF THEIR ART.

The general art of Mexico shows technical skill, but no beauty of sentiment. A few authentic specimens of stone statues show a higher artistic perception, such as the head of an Aztec priestess preserved in Berlin, also another in Hamburg. Their ideal of form was lacking in the human figure; they were more successful in animal figures. Aztec art, however, manifests a great deal of delicacy and decorum. In this it makes strong contrast with Japanese and Peruvian art, which are both indelicate. Their great monuments are found in their architecture throughout the whole Aztec country. The pyramid of Cholula, a day's journey from the city of Mexico, is the most massive monument ever raised in America. Its base covers 45 acres, it is 150 feet high, in terraces composed of stone and brick and natural soil heaped up in layers. It has undoubtedly supported temples, but there is reason to think it was first used for communal residence. Twenty-five miles northwest of Mexico is another pyramid, Teotihuatan, about the same height and occupying one-half the base. Comparison can be made for size with the public buildings at Broad and Market streets, which occupy 4½ acres. Throughout all the valleys of Mexico similar though smaller pyramids are found. The ruins of Mitla, in Tehuantepec, have walls ornamented with the Greek pattern, what is known as walls of Troy or Greeques. In no other edifice of the known world are there so many variations of this pattern as at Mitla, there being 26 different patterns of Greeques. The doors and windows are asymmetrical, or irregular; this is thought to be intentional from some superstitious motive.

IN CENTRAL AMERICA.

The remains of Maya art are most wonderful in elaborateness of design and perfection of execution. At Palenque, very near the western line of Yucatan, and on the other extreme eastern border, the ruins of Copan cover from 50 to 100 acres of ground. Walls, 90 feet high, are still standing, made of massive stone, cut and ornamented in the most elaborate manner; even the laying of such stones must have required excellent mechanical apparatus. These ruins indicate a dense population. The material is a rough limestone, found in that country, cut to angles.

The interior is covered with stucco and painted, and such durable paint employed that the colors have resisted the wear of a tropical climate for at least four centuries. The amount of labor required in these structures is difficult to parallel. In a single courtyard, paved with stone, there are 68,000 cubical blocks. The external decorations are most extensive in their richness; one design will run 300 or 400 feet in length, and from 20 to 30 in height, figures carved in high relief and arranged that it must be seen from a distance or some especial situation to understand the whole. For instance, a fine carved head in one design is set so that it faces upward, looking toward the sky, and is only to be fully seen by getting on top of the wall and looking over at it. There are few instances, but not many, of the arch in Aztec architecture, but it is common in Palenque, both the trefoil and pointed arch. This people, in addition to the buildings which we call temples and convents for want of a better name, constructed roads, bridges, aqueducts; one aqueduct is twenty-four English miles in length. Their roads were narrow, as they had no draught animals or beasts of burden, but they were carried over mountains and morasses. The bridges over streams were of wood and sometimes of stone.



THE PHŒNIX COCK OF JAPAN.

THE PHŒNIX COCK OF JAPAN.

Of all the breeds of fowls that have recently been introduced into Europe, the most remarkable, if not for its beauty, at least for its singular form, is certainly the Phœnix, several living specimens of which are now to be seen at the Jardin d'Acclimatation of Boulogne.

These birds, in aspect and gait, remind one of the English fighting cock, from which, however, they are readily distinguished by their plumage and the enormous development of their tail feathers. Their head is surmounted with a simple, erect comb, which, like the sides of the head, is red. Their neck, which is slightly arched, appears to suddenly taper above, because it is covered with lanceolate feathers which gradually increase in length from above, and which form an ample cloak that covers the origin of the back, but is partly open in front so as to expose the breast. This latter is not, as in most Yokohama cocks, of a maroon or reddish brown mixed with white, but of a uniform blackish tint, which extends over all the lower parts of the body, and offers a strong contrast with the color of the neck feathers, whether these be of an extremely light straw color (as in the "golden" variety) or of a silvery white (as in the variety called "silvery"). The neck feathers usually stand out in relief from those of the back and shoulders, which, in a number of cases, possess a beautiful maroon tint with velvety reflections; but, in other cases, they become more or less confounded in color with a cafe-au-lait tint that is spread over a portion of the mantle. The wings are always variegated with metallic green, black, and white, and the dull black tail is in great measure hidden beneath the primaries, which, like the fore part of the wing, exhibit brilliant green reflections.

The loins are clothed with long drooping feathers that reach nearly to the ground, and the color of which recalls that of the neck feathers. Finally, the bill, iris, and feet do not possess a color that is absolutely constant. Thus, in the golden, duck-winged variety the bill is of a yellowish tint, the eyes are of an orange-yellow, and the tarsi of a pale yellow; while in the silvery duck-winged variety the bill is brownish, the eyes are of an orange-yellow and the tarsi of a leaden gray.

The specimens in the Jardin d'Acclimatation, in their general aspect, recall Dorking fowls, but they do not all wear the same livery. In some, brownish gray is the dominant color of the plumage, while in others it is silvery gray. The neck feathers of the former are more narrowly edged with white than those of the latter, and the abdomen of the latter borders on gray, and their back and wings are striped with gray.

It appears from the observations that have been made upon these fowls that the breed is not as yet well fixed, or that it has already been altered by crossings with other races.

Perhaps there have been alliances at various epochs between the Japanese bird and fowls introduced into the Philippines by the Spaniards. This would explain the tendency shown by certain Phœnix cocks to carry their comb droopingly as Spanish fowls do. As for the origin of the bird under consideration, it is absolutely impossible to fix that with certainty. All that can be said is that it exhibits affinities with the Yokohama breed and with the fighting race, which latter in turn seems to us to proceed more directly than many others from the wild Bankiva cock.—*La Nature.*

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TABLE OF CONTENTS.

PAGE

I. CHEMISTRY.—The Production of Ammonia from the Nitrogen of Minerals.—A paper read before the Society of Arts by Mr. GEO. BEILBY, and discussion following the same.—3 figures..... 7776
Notes on some Japanese Oils..... 7779
The Action of Light on Silver Chloride.—By S. B. NEWBURY..... 7780

II. ENGINEERING AND MECHANICS.—Timber Dry Docks.—The advantages of timber over granite docks.—2 engravings..... 7767
Modern Railroad Facilities.—By WM. BARNET LE VAN.—The fastest trains in the world.—English and French long-distance trains.—America..... 7768
Surface and Elevated Cable Railroads for our Eastern Cities.—9 figures..... 7770
Military Ballooning..... 7771
The Corvette Alexandrine of the German Navy.—With engraving..... 7771
Improved Anchor Gear.—4 figures..... 7771
Heating Buildings by Steam from a Central Source.—By J. H. BARTLET.—Apparatus required, street mains, expense, etc.—With map showing the heating system of New York, tables, and two figures..... 7772
Concrete as a Building Material.—By THOS. POTTER.—A paper read before the Society of Architecture..... 7774

III. ELECTRICITY, ETC.—The Thermomicrophone..... 7774
Illumination of Fountains by the Electric Light.—1 figure..... 7774

IV. ART AND ARCHÆOLOGY.—Sixteenth Century Helmets and Armor.—2 engravings..... 7776
Mexican Archæology.—The bronze age.—Specimens of pottery, statues, jade, etc.—Characteristics of their art.—In Central America..... 7781

V. NATURAL HISTORY.—The Phœnix Cock of Japan..... 7782

VI. MISCELLANEOUS.—Winter Scenes on the Brocken.—6 engravings..... 7780
Bird charmers.—With engraving..... 7780
The Earthquakes in Andalusia.—2 engravings..... 7781
Reply to an editorial in SCIENTIFIC AMERICAN entitled "Patent Office Examinations of Novelty of Invention"..... 7768
Salicylic Paper..... 7779

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